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A DESCRIPTION OF THE CALDWELL STEREOFLUOROSCOPE

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THE Caldwell stereofluoroscope is so arranged as to make possible stereoscopic vision by the alternate excitation of two *x*-ray tubes and by the selective presentation of the screen images to the observer's eyes. F_1 and F_2 in Fig. 1 are the focal spots of the two tubes alternately excited, B is the body under examination, and E_1 and E_2 are the observer's two eyes.

The two tubes are flashed in turn, F_1 giving off rays when F_2 is inactive, and vice versa. These short flashes produce different images on the screen owing to the displacement of the two tubes from each other. The images are present at alternate, very brief intervals and they overlap on the screen so that the resultant appearance is a confusing mixture of the two stereoscopic images. A shutter is placed just in front of the eyes, so arranged that during the instant that F_1 is excited E_1 can see the screen and E_2 cannot, and during the instant F_2 is excited E_2 can see the screen and E_1 cannot. This shutter, alternately permitting the eyes to see the screen in synchronism with the flashes of the two tubes, serves as a selector of the two stereoscopic images, which are displaced in point of time but not in point of space. Thus each eye sees only the one image that is intended to reach it for stereoscopic vision. The period of lag of fluorescence in the crystals of the screen is well within the period of persistence of an image in the eye, so that the observer is conscious only of a continuous image similar to that produced by the successive images of a moving picture. Here, however, sixty images appear to the eye in each second, and in the motion picture only sixteen.

The general arrangement of the machine as shown in Fig. 2 (the photographs illustrate an early model, none of the later design being available) is as follows: (1) is the transformer which supplies power to both tubes; (2) is the box containing the tubes and diaphragms; (3) is the table frame, with bakelite stretcher top omitted; (4) is the screen mount; with shutter and viewing holes at (5); and (6) is the apron in which the operator stands and from which he controls the movements of the tube and screen and the electrical operation of the tubes. The tubes and screen are always maintained at constant distance from each other but they may be shifted into any position up and down, to bring the screen close to the part being examined, or laterally and lengthwise of the table. The stretcher top carrying the patient may also be shifted lengthwise on the table, so the adjustment of the machine to the part

under examination is a very easy matter. Fig. 3 shows the machine in use.

Screen and Shutter.—The fluoroscopic screen is made circular in shape and a small size is provided as well as the regular large size to enable it to be brought down close to certain parts inaccessible with the large screen. Both screens are mounted in deep bakelite casings which may readily be kept sterile and serve to protect the screens from blood and disinfecting solutions. The upper surface of the screen is, of course, covered over by lead glass which serves as a protection from the *x*-rays.

The shutter, from the standpoint of design and construction, is the most difficult feature of the whole machine. It must synchronize absolutely with the illumination of the screen, which is produced by successive alternations of the supply current to the transformer as described later. If the machine is being operated on 50-cycle current, there will be fifty impulses through each tube every second and the shutter must run absolutely synchronous if stereoscopic vision is to be possible. The shutter, which is quite similar to a moving picture shutter, has three wings which serve to cut off the vision through the eye holes and three open segments which allow the light to pass. Fig. 4 shows the shutter in relation to the eye holes.

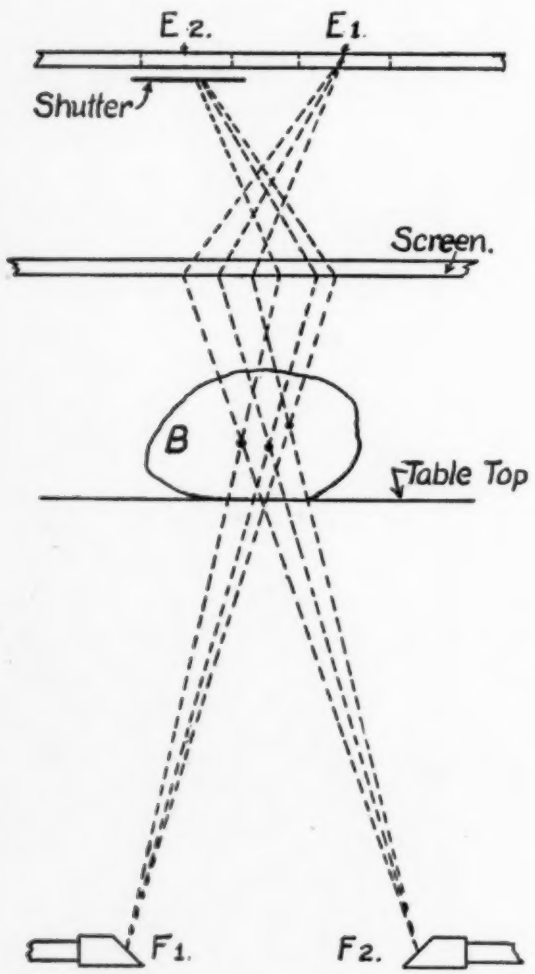


FIG. 1. ARRANGEMENT OF TUBES, SCREEN AND SHUTTER.

The driving of the shutter is accomplished by making it the rotor of a motor, the field windings surrounding it and placed just beneath the face plate. The electrical details of this motor need not be gone into further than to say that it is a salient-pole type of synchronous motor similar in principle to those used to drive the high tension rectifiers of *x*-ray machines. The problem of starting and running on a single phase line has not yet been satisfactorily solved. Meanwhile the shutter is operated on two phase current from a small auxiliary converter. While it is theoretically possible to obtain two phase current from single phase by properly balancing two circuits containing respectively an inductance and a condenser, the difficulties encountered have made it too delicate and temperamental a balance for practical work up to the present time. Major Caldwell was very much interested in this matter of phase-splitting and hoped to eliminate the auxiliary two phase convertor. The great difficulty with all synchronous motors of this type is that they have very little torque to hold them in synchronism; and no torque for starting unless an auxiliary split-phase starting winding is provided. It is hoped to obtain a motor that will be easily started from a single phase line, that will hold synchronism well without oscillation or "hunting," and if possible, to operate over such a

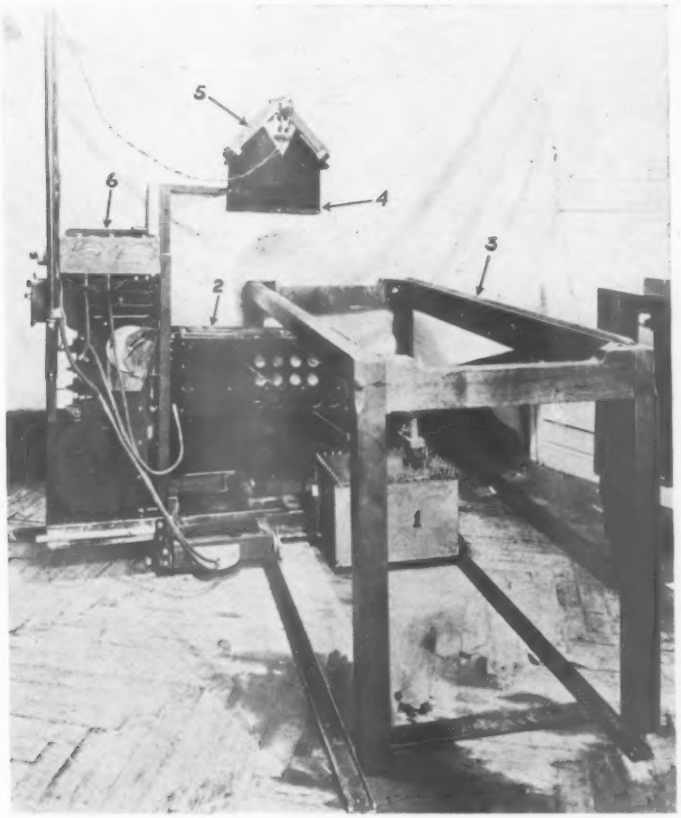


FIG. 2. GENERAL VIEW OF THE APPARATUS. TABLE TOP REMOVED.

FIG. 3. STEREOFLUOROSCOPE IN USE. TUBES AND SCREEN MAY BE SHIFTED IN THREE DIRECTIONS.

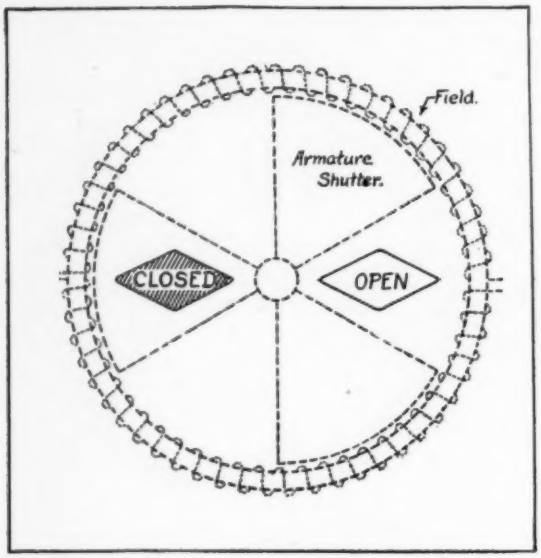


FIG. 4. PLAN OF SHUTTER AND ITS RELATION TO THE VIEWING APERTURES.

range of frequencies as will be encountered in the military service abroad.

Tubes and Diaphragm.—For the production of a good stereoscopic screen image it is essential that the radiation from one tube be very closely the same as that from the other tube, both as to penetration and intensity. The gas tube presented great difficulties in the stereofluoroscope, since it was almost impossible to obtain two tubes that would give equivalent radiation and would continue to do so. The Coolidge tube, which is under control as to current and penetration, offered a very satisfactory solution of this difficulty.

Two self-rectifying Coolidge tubes are used, but owing to space considerations they are smaller than the ordinary size of self-rectifying tube as used on the U. S. Army Portable Unit and Bedside Unit. No mechanical rectifier is needed in the operation of these tubes and a source of considerable trouble is eliminated. These tubes are so connected that one will allow current to pass on one direction of the alternating voltage from the transformer and the other tube will allow it to pass on the wave in the other direction. By this connection the tubes are made to flash alternately, and there is eliminated the objectionable high inverse voltage which is present in the operation of a single self-rectifying tube. The filaments are lighted by two transformers, included in the case with the high tension transformer, and means are provided to balance them to give the same current on each tube, and when balanced to increase or decrease both tubes alike.

The tube box is provided with a double diamond shaped diaphragm controlling the

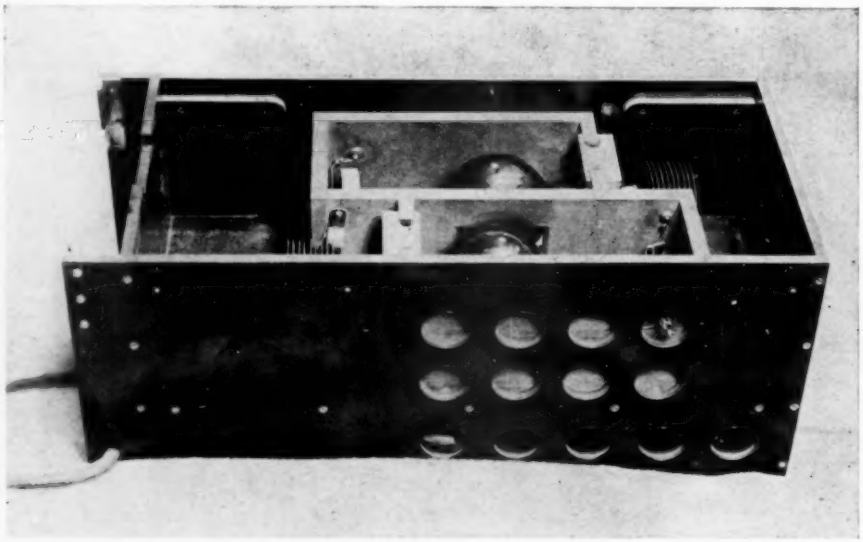


FIG. 5. TUBE BOX, SHOWING SPECIAL COOLIDGE TUBES. DIAPHRAGM REMOVED.

rays from both tubes by a single handle, since they do not require individual control. The diaphragm control is in the operator's left hand as shown in Fig. 3. The tube box, with the diaphragm removed, is shown in Fig. 5. The box is constructed of lead-loaded bakelite.

Electrical System.—The electrical system is shown in approximate diagram in Fig. 6. It is fundamentally a simple apparatus and the electrical circuits are likewise simple. The main line is assumed to give alternating current, and it supplies the main primary, the filament, and the shutter circuits. In case the available supply were D. C. a rotary converter would be used

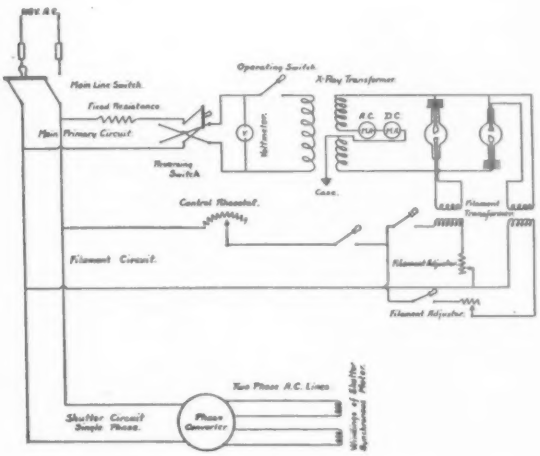


FIG. 6. DIAGRAM OF ELECTRICAL SYSTEM OF THE STEREOFLUOROSCOPE.

with an extra pair of slip rings to give the desired two phase current for the shutter and the phase converter would be eliminated. The remaining circuits, however, would be unaffected except that all current would have to pass through the rotary. The main primary circuit includes simply a fixed resistance, a reversing switch and the operating switch. The filament circuit includes a rheostat control lever (in the operator's right hand, Fig. 3), this rheostat controlling the current through both tubes. Adjustment resistances are used, as shown, to balance the current through the tubes individually. Note that the tubes are connected to the high tension lines oppositely, and that the two filament transformers are needed for insulation purposes. A single transformer could not be employed to light both filaments in this connection.

Control.—When resistance is included in the primary circuit of a transformer an increased current demand results in a lower voltage from the secondary. This feature is inherent in all rheostat controlled *x*-ray machines and is decidedly a disadvantage in roentgenography. As applied to the stereofluoroscope with a fixed resistance of the proper size it makes a very simple and practical method of control. In using a high gap for fluoroscopy very little current is needed for good screen illumination; and in using a less penetrating ray for greater contrast in the image between soft and dense parts, a larger current becomes necessary. By moving the control lever the current and voltage are changed oppositely, but so that the resultant screen brightness is nearly constant. Fig. 7 shows such a relation between current and voltage. This makes

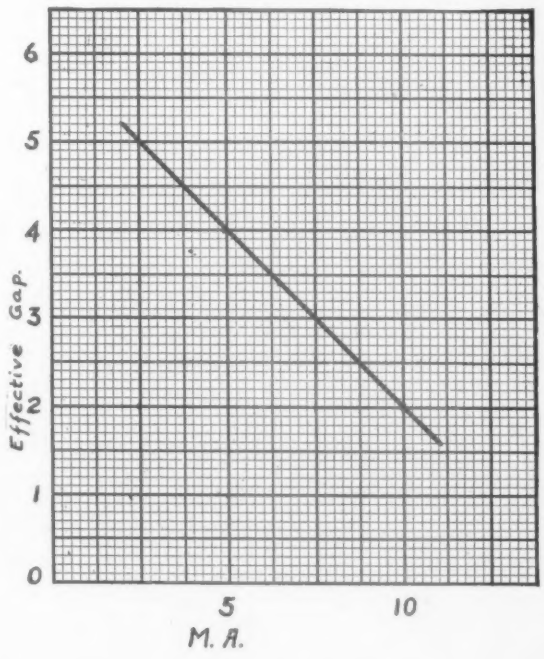


FIG. 7. CHART SHOWING RELATION OF VOLTAGE TO TUBE CURRENT.

an exceedingly convenient control for fluoroscopic work and renders available a range of penetrations for getting the greatest possible information out of the fluoroscopic examination and to give the best stereoscopic image in a particular case.

Meters.—The following meters are used. A. C. voltmeter; A. C. milliammeter; D. C. milliammeter. The A. C. voltmeter is connected across the primary lead wires of the step-up transformer and by measuring the voltage maintained at the primary it serves as an index of the secondary voltage applied to the tubes. It is in this case a reliable guide since the difference between maximum and minimum current is not so great as on a large *x*-ray transformer where such a meter is not of very much service.

The two milliammeters read respectively the sum and difference of the currents flowing in the two directions through the secondary of the transformer. Both meters are inserted at the grounded mid-point of the secondary in order that they will be safe to touch and may be placed conveniently near the operator. The tubes being in proper balance the direct current meter should read 0 m. a. If the needle swings to the right, the tube to the right is drawing an excessive current by the amount indicated; and if it swings to the left, the left tube is drawing the most current. So long as the tubes draw the same current, no matter how much or how little that current might be, this meter will indicate zero. The A. C. milliammeter gives an indication of the total current and serves in that way as an operating guide. It may be remarked that if the two tubes are balanced as regards current they will be operating on the same working voltage, but if they are not balanced in current they will not be balanced in voltage, the tube with the heavier current receiving the lower voltage. The meter board detached from the machine is shown in Fig. 8.

Pseudoscopic Image.—If the shutter is thrown into synchronism in the wrong position the image on the screen which should be presented to the right eye will be presented to the left and vice versa. The resultant image in space will now appear above the screen instead of below it, and will be pseudoscopic instead of stereoscopic. The image will undergo a transposition symmetrically with respect to the screen. It then becomes possible to insert a pointer to the interior of the image and to measure the actual distances between different landmarks. Or, if the pointer be connected to a pantographic apparatus, it becomes possible to trace the image and produce a cross sectional drawing of the part being examined. The change between the pseudoscopic and stereoscopic images is readily made by means of a reversing switch in the main primary circuit.

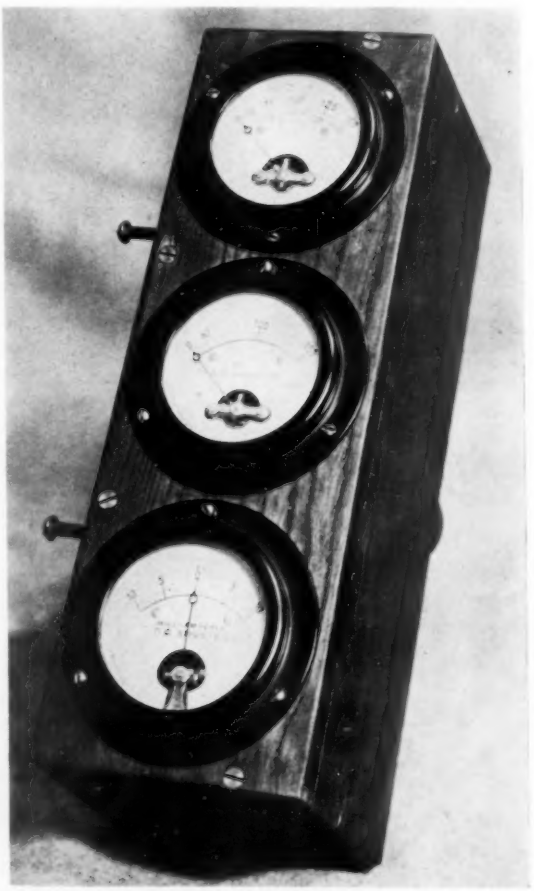


FIG. 8. METER PANEL DETACHED FROM THE MACHINE. SHOWING PRIMARY VOLTMETER, SECONDARY A-C. MILLIAMMETER, AND SECONDARY D-C. (LOAD BALANCING) MILLIAMMETER.

Usefulness of the Stereofluoroscope. — Nothing has been said herein concerning the actual use of the machine and its application to problems of the *x*-ray examination, to diagnosis, or to the localization of projectiles. It is unwise at the present time to give much more than a description of the apparatus since sufficient operating experience is not at hand upon which to base further study. Major Caldwell himself took the attitude that only by long and continued use under actual working conditions could a rational opinion of its usefulness be formed, and until this is done judgment may best be withheld. One of the machines has recently been shipped, and will be put overseas to the test of real service.

THE RATIONALE OF RADIOTHERAPY IN UTERINE HEMORRHAGE

The roentgen-ray destroys the Graafian follicle, which in turn controls menstruation, and hence menstruation can be controlled by the use of the *x-ray*. Similarly, abnormal uterine bleedings can be controlled, as the majority of them arise from disturbances in the menstrual mechanism, and not to local mechanical causes.

Radium also possesses a local cauterizing effect on the uterine cavity. In women of the late child-bearing period radiotherapy is the procedure of choice. In girls radiotherapy should be used as a late procedure. The induction of an artificial menopause for economic reasons is possible. Whether it is justifiable or not is a matter for discussion.

In fibromyomata associated with bleeding, the same result, amenorrhea, follows, as it does in uterine bleeding, from a grossly normal uterus. The fibromyomatous mass shrinks as a result of the radiotherapy to a marked degree, often to an extent that permits the mass to escape palpation. Unless the fibromyomata cause symptoms, they should remain untreated. Radiotherapy is the treatment par excellence, when hemorrhage is the only symptom, because it reduces the condition to the symptomless class. Since the amenorrhea should be permanent, radiotherapy is particularly ind cated for women of thirty-eight years or over, while it should be restricted more and more as the age is lower. Where mechanical symptoms predominate they are best treated mechanically, *i. e.*, by operations.

The uterine bleeding as treated in eight girls was controlled with varying success in all cases. In three the menses became almost normal; in five an amenorrhea of varying duration was induced. In one instance there were severe hot flushes for a period covering nine months.

Radium appears to exert the same influence as *x*-ray therapy. The advantage of radium over the *x*-ray is that one treatment carried over twenty-four hours usually suffices for results. With the *x*-ray, the treatment is spread over six to ten weeks. Uterine hemorrhage from any cause may be stopped by the intrauterine application of radium. Hemorrhage from disturbed menstruation with or without fibromyoma may be controlled by the *x*-ray. Practically all fibromyomata will shrink to a satisfactory degree after radiotherapy, while no harm results.

All cases of hemorrhage from a grossly normal uterus in women of thirty-eight or over should be treated by radiotherapy after carcinoma has been ruled out by a diagnostic curettage. In younger women radiotherapy should be used only as a late resort. For uterine hemorrhage associated with fibromyomata of the uterus, radiotherapy is indicated, if symptoms from mechanical causes are absent and the woman is over thirty-seven years of age. —J. A. CORSCADEN, *American Journal of Obstetrics*, February, 1918.

THE STEREOSCOPE IN ROENTGENOGRAPHY*

BY EUGENE W. CALDWELL, B.S., M.D.

IT IS well known to all of us that the roentgenogram is only a shadow picture, and that for this reason we sometimes have difficulty in interpreting it correctly. We are accustomed to drawings and photographs which give us a fair idea of perspective, and most of the so-called errors of the *x*-ray are due to our failure to regard the roentgenograph not as a photograph or drawing, but as a shadow picture or silhouette. It is true that roentgenographs used in diagnosis differ from the black and white silhouette because the *x*-rays penetrate more or less readily every part of the human body and therefore give us shadows which vary in intensity according to the varying thickness (and opacity to *x*-rays) of the different structures through which they pass.

The shading thus produced gives us an impression of perspective which may be accurate enough to show the cylindrical form of some of the bones, but it gives us little or no idea of the distances between different parts in a direction perpendicular to the plane of the plate. In order to show all of the space relations it is therefore customary to make two roentgenograms in which the plane of the plate and the general direction of the rays are arranged at an angle of ninety degrees from each other.

For examination of fractures of the long bones, and for localization of foreign bodies which lie very near the surface, this method is sufficiently accurate. It is easily carried out, and in such cases is probably the most practical procedure. There are, however, certain parts of the body, as the shoulder and hip-joint, where for obvious reasons we can obtain a roentgenogram only when the rays pass approximately in the sagittal direction, and a second roentgenogram from a position at right angles from the first is practically impossible. For the localization of foreign bodies lying far below the surface, and which cannot be brought close to the plate, the above method is not sufficiently accurate, unless the direction of the rays which cast the shadow of the foreign body in each roentgenogram is as nearly as possible perpendicular to the plane of the plate. This condition may be obtained by first ascertaining the position of the foreign body with the fluoroscope, then arranging the photographic plates and the source of the roentgen-ray in correct positions. Several very ingenious appliances have been designed for accurately carrying out this technique.

It is obvious, however, that if a foreign body can be plainly shown on the fluoroscopic screen in two positions, the localization thus obtained is so satisfactory as to make roentgenograms unnecessary. In practice, we find that many cases of foreign bodies which the fluoroscope fails to show sufficiently well for such localization, or perhaps does not show at all, may be readily shown by the roentgenograms.

It is evident, therefore, that any process which will lend perspective to our plates, especially to those which show foreign bodies or injuries in the shoulder and hip-joint, will have a fine field of usefulness.

Our normal appreciation of the space relations of the things we see is a complex process, and is dependent upon a large number of factors which I shall not undertake to discuss in this paper. The most important of these factors are: First, the fact that the size of the image on the retina varies with the distance of the object; secondly, the fact that our two eyes see from slightly different points of view. Therefore we have two pictures from which the brain by an obscure process of triangulation unconsciously estimates the varying distances of different objects.

* This paper was probably read before a New York medical society about 1906. But we are unable to find a record of its publication.—EDITOR.

In the ordinary photograph, or drawing, the image on each eye is practically the same as if the object were viewed with one eye; that is, the picture presented to each eye is the same. If, however, we have two photographs made from points of view differing by a few inches, or approximately the distance between the two eyes, and view them in such a way that the two pictures are presented to the two eyes separately, we obtain this effect of triangulation, and the impression of perspective is much heightened. This principle is employed in the ordinary Brewster stereoscope and in the small stereoscopic views of Indian temples and ruins of Egypt familiar to all of us.

Soon after the roentgen-ray came into use Professor Elihu Thomson suggested that a pair of roentgenographs in which the two pictures which are made with a tube displaced about the distance between the two eyes when viewed in a stereoscope, would give us the effect of perspective. Early in 1896, Thomson reported some experiments of this nature in the *Electrical Review*, and since that time a large number of experimenters have made improvements in the apparatus for making and viewing roentgenographs of this sort.

In the ordinary Brewster stereoscope the size of the pictures is limited to about 2½ inches in width, or a little more than the distance between the pupils of the eyes. By far the great majority of our roentgenographs must be much larger than this, and we must either reduce them to the size suited to the ordinary Brewster stereoscope, or employ some other means of viewing them stereoscopically.

Early in 1897 Dr. Mackenzie Davidson of London devised a special means for conveniently making the stereoscopic roentgenograms, employing the Wheatstone stereoscope for viewing them. With the Wheatstone stereoscope we may use pictures of any size used in roentgenography. In this instrument the two pictures are placed opposite each other, and are viewed in two mirrors placed between them at right angles to each other in such a way that the right eye sees the reflection of one picture and the left eye the reflection of the other.

In viewing stereoscopic pictures it is supposed that the distance of the reflected beam of light from the eye to the picture should be about the same as the distance between the source of the *x*-ray and the plate when the plates were made. Theoretically this condition would seem important, but in practice it is found that the distance from the eye to the plate may be varied within wide limits. It is of course essential that the two plates should be adjusted to the same level so that the images would coincide at every point. In most of the Wheatstone stereoscopes, means are supplied for adjusting the plates until this condition is obtained. In order to assist in leveling up the pictures it is very valuable to place over the plate when the exposures are being made a ribbon of wire or metal which casts a shadow on the plate, of which the edge is parallel to the direction to the movements of the tube in the two exposures.

In viewing stereoscopic pictures the impression of perspective, which is due almost entirely to the fact that having the two points of view and the variations in the size of the images of the different parts according to the distances from the observer, is practically absent in the roentgenogram, and gives us no help. We may readily reverse the position of the two plates and thus obtain a pseudo-stereoscopic effect, and make the parts which were more distant in one position appear even nearer in the other.

In making exposures for a pair of stereoscopic roentgenograms it is necessary that the movements of the tube be in a line parallel to the base line of the plates, as was before suggested, and that there be no change in the position of the subject during the two exposures. In Mackenzie Davidson's apparatus for making stereoscopic exposures the tube is held in a holder attached to a beam supported

above the plate in a direction parallel to its base. The object to be examined is supported upon a box with a sheep-skin top, which material offers very little obstruction to the *x*-rays. The two plates may then be slipped under the sheep skin, removed and replaced without disturbing the position of the subject. The envelopes in which the *x*-ray plates are ordinarily enclosed are considerably larger than the plates themselves. Therefore we cannot depend upon the side of the plates for a base line. In roentgenograms we have no horizon, and it is therefore difficult to obtain this base line without some artificial means. Mackenzie Davidson accomplishes this very important feat by stretching across the sheep skin a wire parallel to the beam supporting the tube. The method of using this apparatus is very simple. The plate is inserted under the sheep-skin top of the box. The exposure is made. This is removed and replaced by another plate, the tube holder moving along a horizontal bar the desired distance. The second exposure is made in the same way. The displacement of the tube in the two exposures depends, of course, upon its distance from the photographic plate and to some extent upon the thickness of the parts to be roentgenographed. If the movement is too small the stereoscopic view is flat and lacks perspective; if it is too large we get an exaggerated impression of distances and a very tiring effect upon the eyes. In practice, however, a considerable range in the amount of this movement may be made without loss of the stereoscopic effect. The source of the *x*-ray is then about 12 inches from the plate and the best results will be obtained when the tube is moved through a horizontal distance of about 2½ inches. If the distance between the tube and plate is increased the distance of the movement should be correspondingly increased, but if the object to be roentgenographed is very thick and the distances between the different parts are great, a smaller horizontal movement should be made than in the case where the object is small and every part of it lies close to the plate. The work of Thomson and Mackenzie Davidson is the foundation of all that has been done in stereoscopic roentgenography. Davidson's method of making the exposures has been universally employed, with various improvements and modifications, and the Davidson Stereoscope for viewing the roentgenograms has been more extensively employed in this country than any other design. Dr. L. A. Weigel of Rochester, Dr. A. B. Johnson of New York, Dr. Hultz of Grand Rapids, Michigan, and others have added valuable improvements to the technique of the apparatus.

The stereoscopes of Weigel and Johnson are both constructed on the Wheatstone plan and are fitted with many conveniences which adapt them for use with roentgenographic negatives. Johnson's stereoscope is provided with a bellows between the two mirrors and the roentgenographic negatives, to exclude diffused light, and to enable the negatives to be examined in a lighted room.

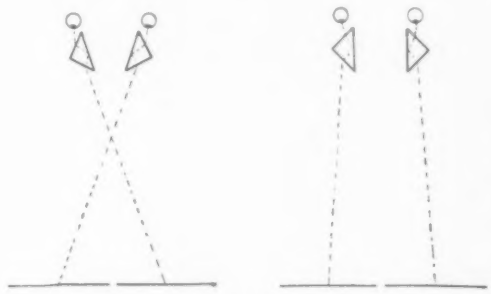
The difficulty and some tedious technique of making stereoscopic roentgenograms and the clumsiness and variety of adjustment necessary for viewing them in the Wheatstone stereoscope have prevented this method from coming into general use. It is obvious that if two stereoscopic roentgenograms can be permanently mounted together, as by the ordinary stereoscopic photograph, it would save many difficulties of leveling and adjusting and would materially help toward bringing the art into everyday practice.

Dr. Walter of Hamburg has described in the *Fortschritte auf dem Gebiete der Roentgenstrahlen* for October, 1902, a number of stereoscopes which accomplish this result. The first of these is a mirror stereoscope, which is like a large Wheatstone stereoscope with two additional mirrors which reflect the light so that the two pictures may be placed in the same plane. Doctor Walter has pointed out that in all mirror stereoscopes there is a

reflection from the surface of the glass as well as from the silver at the back of the mirrors which causes some blurring of the images. The mirror stereoscope of Walter's is really a modification of the Helmholtz stereoscope which was designed for viewing distant objects with a general appreciation of distance. Doctor Cowl of Berlin has shown that if the two outside mirrors of this arrangement be so placed that they may be rotated by a vertical axis to bring the pictures into alignment, a much smaller device than that of Walter's may be used. In Doctor Cowl's stereoscope the mirrors are about $1^1/_8$ inches square and are placed very close to the eye.

The writer has found that the blurring of the images by reflection from the surface of the glass may be entirely obviated by substituting for mirrors right-angle reflecting prisms. When the prisms are used the beam of light enters and emerges from the glass in a very nearly perpendicular direction. There is little reflection, and it is in such a direction as not to enter the eye. Walter in the article mentioned describes also a prism stereoscope for viewing large pictures. He has suggested turning the prisms on a vertical axis to see the crossing of the images and reversal of the picture. He points out the fact that with this prism stereoscope there is a distribution of the rays by the prisms and color effects are produced. This he says may be obviated by the use of achromatic prisms, which are difficult to obtain and very expensive. He concludes by stating that the best form of stereoscope is that which he calls his lens stereoscope. This is really a combination of a camera and the ordinary Brewster stereoscope. By the camera lens the images of the pair of roentgenograms to be examined and which are of proper size for the Brewster stereoscope, are produced. Behind the lens of the camera are placed the two lenses of the ordinary Brewster stereoscope. The separate image is thus presented to each eye as though the eye were viewing the plates through a telescope. Walter has pointed out the fact that in this instrument it is necessary to use in the camera a lens of wide aperture and very short focus. Such a lens as Walter suggests is quite expensive, but is a very useful piece of photographic apparatus. Although very effective this lens stereoscope of Walter is much too expensive as well as too complicated to come into general use.

For some time I have been using a prism stereoscope, the principle of which I supposed was new, but recently I have found that this arrangement of prisms for viewing stereoscopic pictures is very old.



Indeed I have been unable to find out with whom it originated, and whom to credit for it.

The prisms in this apparatus are standard right angle 25 millimeter prisms. They are arranged to be rotated at a vertical axis. The direction of the beam of light through the prisms is such that it suffers total reflection, and we therefore see a mirror picture of the roentgenogram. Another effect of this reflection is that the dispersion of the beam of light as it enters the prism is corrected as it emerges. Chromatic effects are therefore obviated and it is unnecessary to use achromatic prisms. This instrument is smaller than an opera glass, and the adjustment of the angles of the prisms is made in a way somewhat similar to the focusing of an opera glass. The advantages of the instrument are its small size and its comparatively low price. With 25 millimeter prisms one may view stereoscopic pictures of any size up to 12 x 24 inches at a distance of two to three feet. Pictures larger than this

cannot be conveniently mounted side by side, and I am inclined to think that they can be viewed in the Wheatstone stereoscope with more satisfaction.

I have found it very convenient to make two stereoscopic negatives on the same plate. This method obviates all difficulty of adjusting the two pictures to the same level, and prevents the possibility of a pair of them being separated. Obviously it also saves time and trouble in every stage of making the negative.

SUPPLEMENTARY NOTE

SINCE the foregoing article was written, changes have been made in the general design of the prism stereoscope but the optical principles are unaltered.

Each prism is mounted on a pivot which, in turn, is mounted on a plate. The necessary angular relation is obtained by swiveling the prisms on their pivots and the necessary inter-pupilary distance is obtained by symmetrically separating the plates.

It is plain that both these motions must be symmetrical and that the swiveling and separating must be movements independent of each other. The mechanism by which these motions are accomplished is illustrated in Fig. 1, which shows an under view of the apparatus. The separation of the prisms is accomplished by the lower shaft and, by virtue of its engagement with the right and left threads, the prism bases are symmetrically separated by the knurled head at the left. The angular relation of the prisms is obtained by rotation of the upper shaft in the illustration. The same knurled head is utilized by simply shifting it into engagement with the squared upper shaft. The prism bases are directly connected to the squared upper shaft through levers which contribute angular motion to the prisms themselves. A study of the picture will show that rotary motion of this upper shaft will result in swiveling the prisms equal amounts. As the worm wheels are slidably mounted on the upper shaft, rotation of the latter affects only the angular relation of the prisms, conversely the same slidable motion makes the angular position of the prisms independent of any rotation of the lower shaft.

Two star spring washers, one on each prism pivot, afford enough friction to hold each prism in any angular relation to which it may be adjusted.

A general view of the prisms and their relation to each other is shown in Fig. 2. Fig. 3 shows the apparatus equipped with suitable mounting and blinders.

—[HANCHETT]

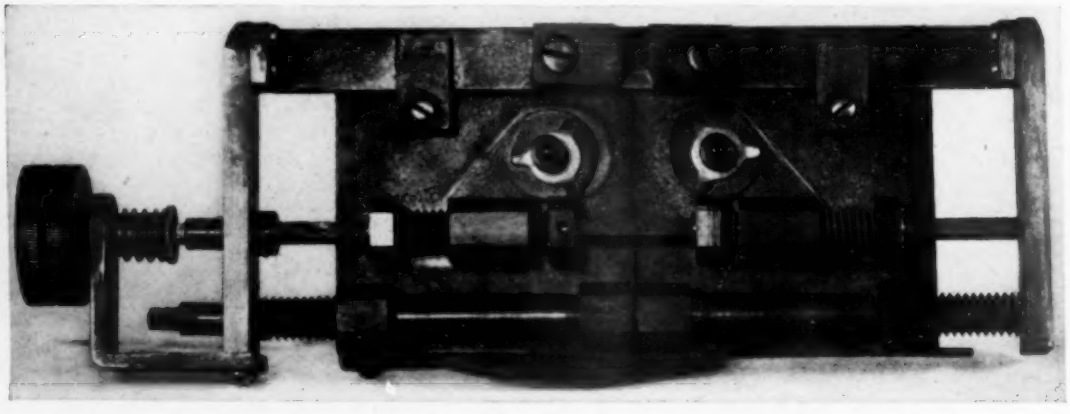


FIG. 1. UNDER VIEW OF THE CALDWELL PRISM STEREOSCOPE.

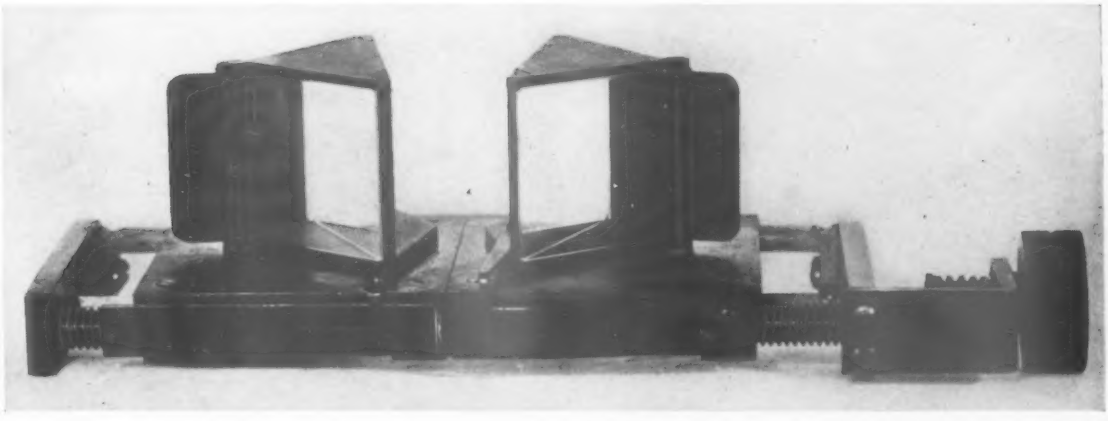


FIG. 2. GENERAL VIEW OF PRISMS AND THEIR RELATIONS TO EACH OTHER.

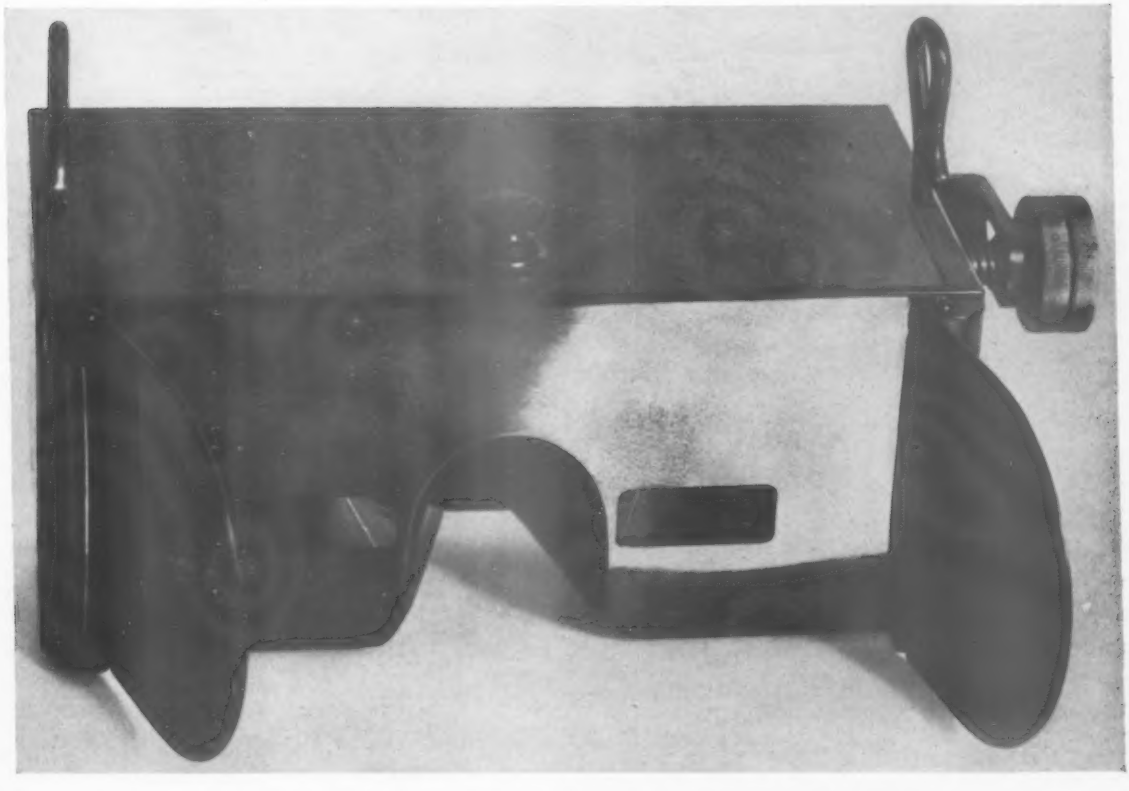


FIG. 3. APPARATUS EQUIPPED WITH SUITABLE MOUNTING AND BLINDERS.

CALDWELL TILT TABLE FOR FLUOROSCOPY

BY GEORGE HANCHETT, M.E.

NEW YORK

THE object of this apparatus is to combine in one the advantages of the vertical and horizontal fluoroscopes with the additional advantage of supporting the patient at any angle, from the vertical position to the Trendelenburg.

The general view of the table is shown in Fig. 1. It comprises a rectangular frame long enough to support the subject and is pivoted at its middle on a base like a cheval mirror.

This tilting motion is performed by a worm wheel and sector which is connected by a train of spur gears to a small motor. The motor is electrically connected to run in either direction by holding closed an appropriate button. The electric circuits are provided with limit switches which stop the motor in the extreme positions of travel. It will be seen that the table is locked in any position in which it is stopped, for the worm sector is not a reversible combination.

The fluoroscopic screen is pivoted by a double-hinged joint to the main rectangular frame of the apparatus. The movement of this screen by the side of the large rectangular frame is affected through a worm wheel and chain combination, so that it can be racked up and down the length of the frame.

The roentgen-ray tube is contained in a box equipped with sheet lead shutters. This box is mounted on a track directly beneath the celluloid screen. By simply putting pressure upon it the track permits the tube box to slide longitudinally with reference to the main frame. It is also slidable transversely with reference to the main frame by tilting a vertical lever from side to side. As the tube and screen can be moved independent to each other, though following the main frame, it is obvious that they can be placed in any position with reference to the main frame without disturbing any other adjustment.

It remains to control suitably the radiation proceeding from the tube box. This is done by two pairs of lead shutters mounted on the tube box itself at right angles to each other. The shutters are manipulated in pairs by a system of pulleys. The axes of these pulleys comprise shafts upon which the pulleys are slidably mounted, so that the position of the shutter is entirely dependent upon the rotary motion of the shafts and not at all upon motion that may result from movements of the tube box. These shafts, which are two in number, one for each pair of shutters, are connected to flexible Bourdon wires and rotary knobs mounted on the same side handle that forms the lever which controls the position of the tube box. The electrical connections which supply the high tension current are attached to the extreme ends of the table. These show plainly in all figures, particularly in Figs. 2 and 3. It is at once apparent that as the table moves, the connections must readily follow. To permit this they are connected to the table from permanent positions by means of flexible cords, the slack of which is taken up with an automatic take-up, somewhat similar to the Hartshorne shade roller. These take-up reels are made of fiber and are displayed in Figs. 5 and 6. Fig. 5 shows the assembled take-up. This is mounted on a pin on which it can swivel and be located at any convenient point. Fig. 6 shows the details of the take-up mechanism, consisting of a reel actuated by a large spiral spring. This serves to keep the connecting cords taut at all times.

The method of using the table is largely apparent from the foregoing description of its construction and the accompanying photographs, but perhaps it may be well to review the method directly.

The subject stands on the platform at the bottom of the apparatus and leans

FIG. 1. CALDWELL TILT TABLE.
Special attention is directed to the step, the celluloid back, the mechanism for the support of the fluorescent screen, the control levers, the strap and screw eyes for securing the patient.

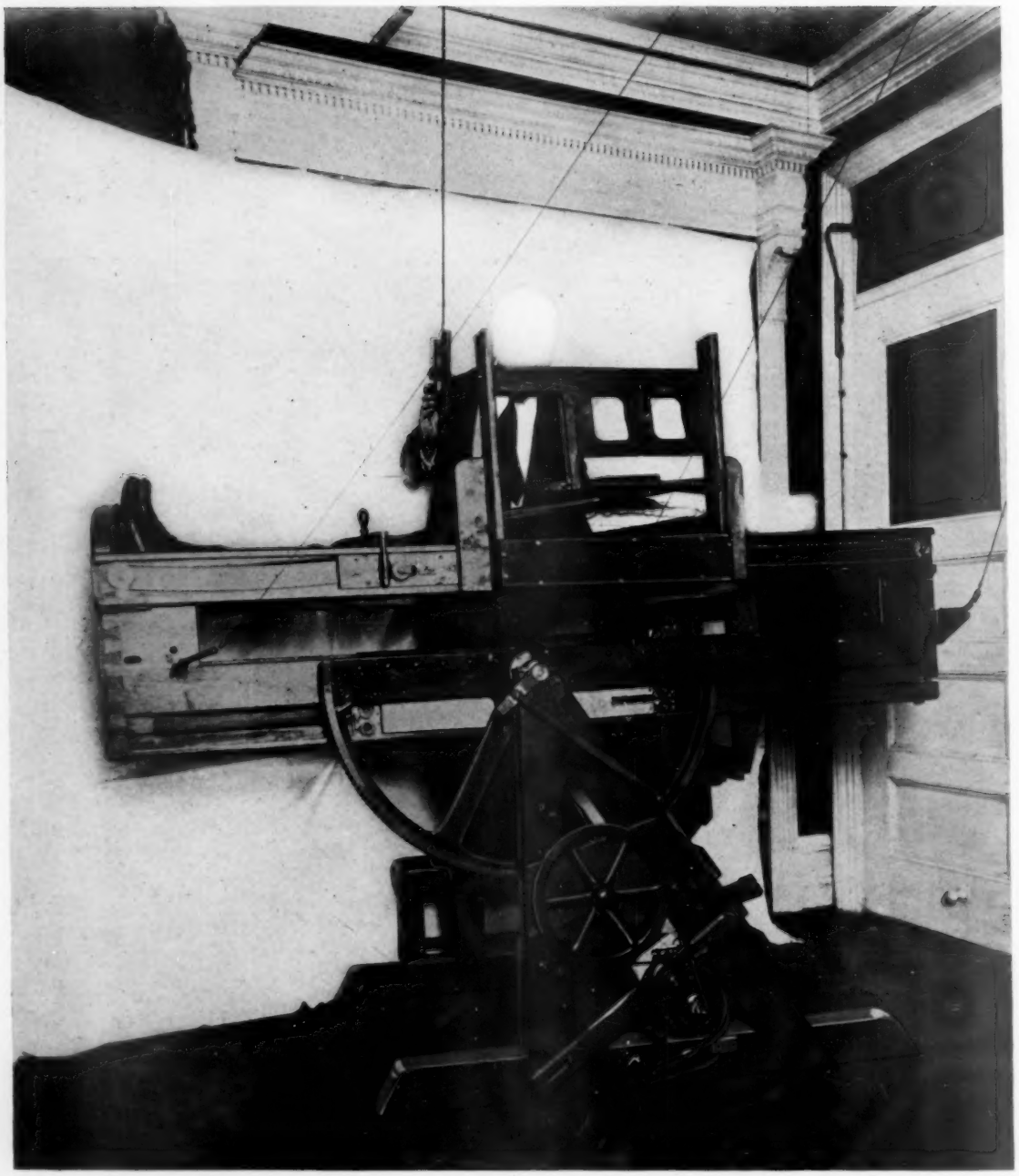


FIG. 2.

The table in the horizontal position. Attention is directed to the worm gears and the motor.

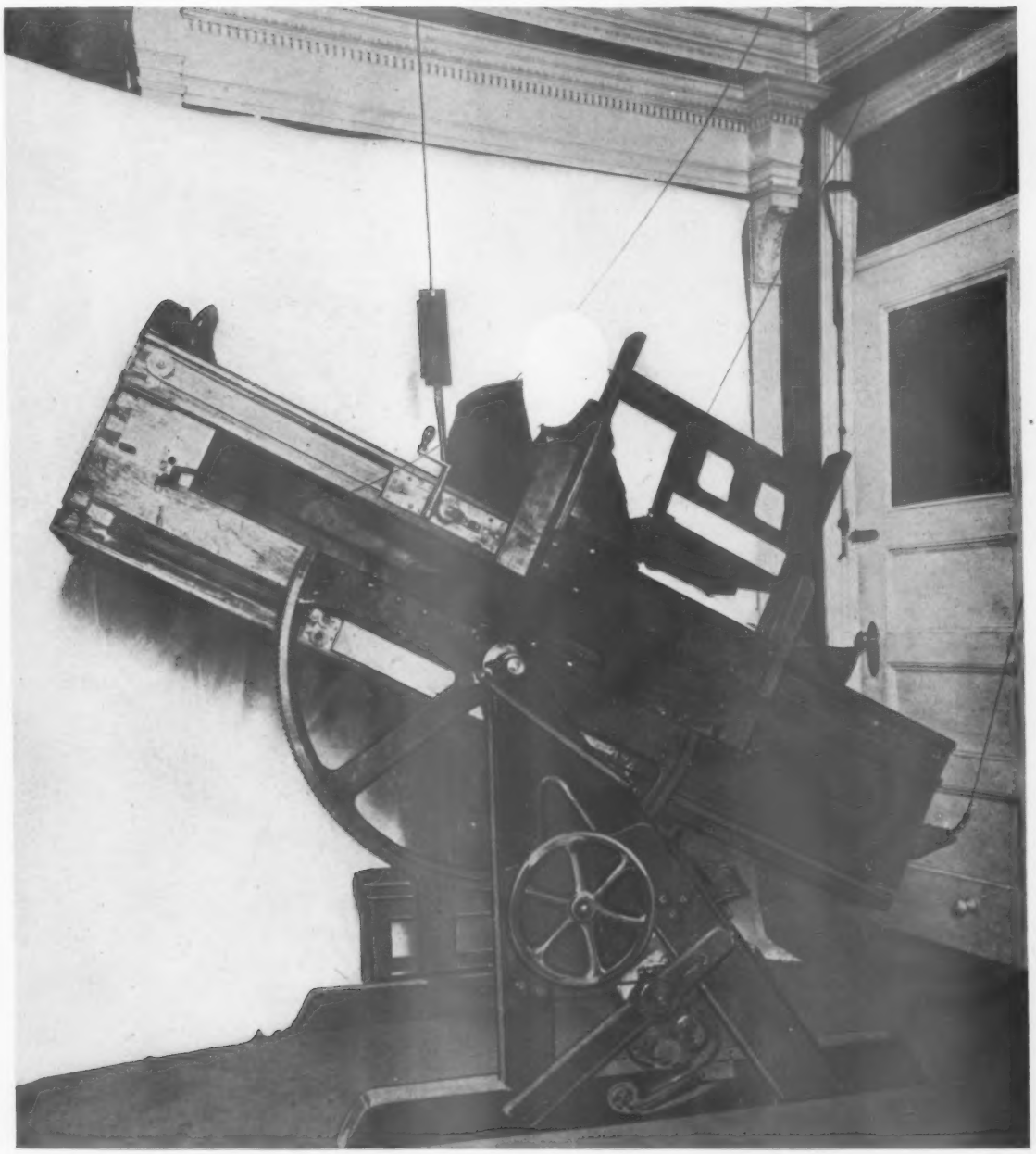


FIG. 3.

The patient in partial Trendelenburg position. Attention is directed to the high tension terminals.

FIG. 4.

The worm gear control for the fluorescent screen.

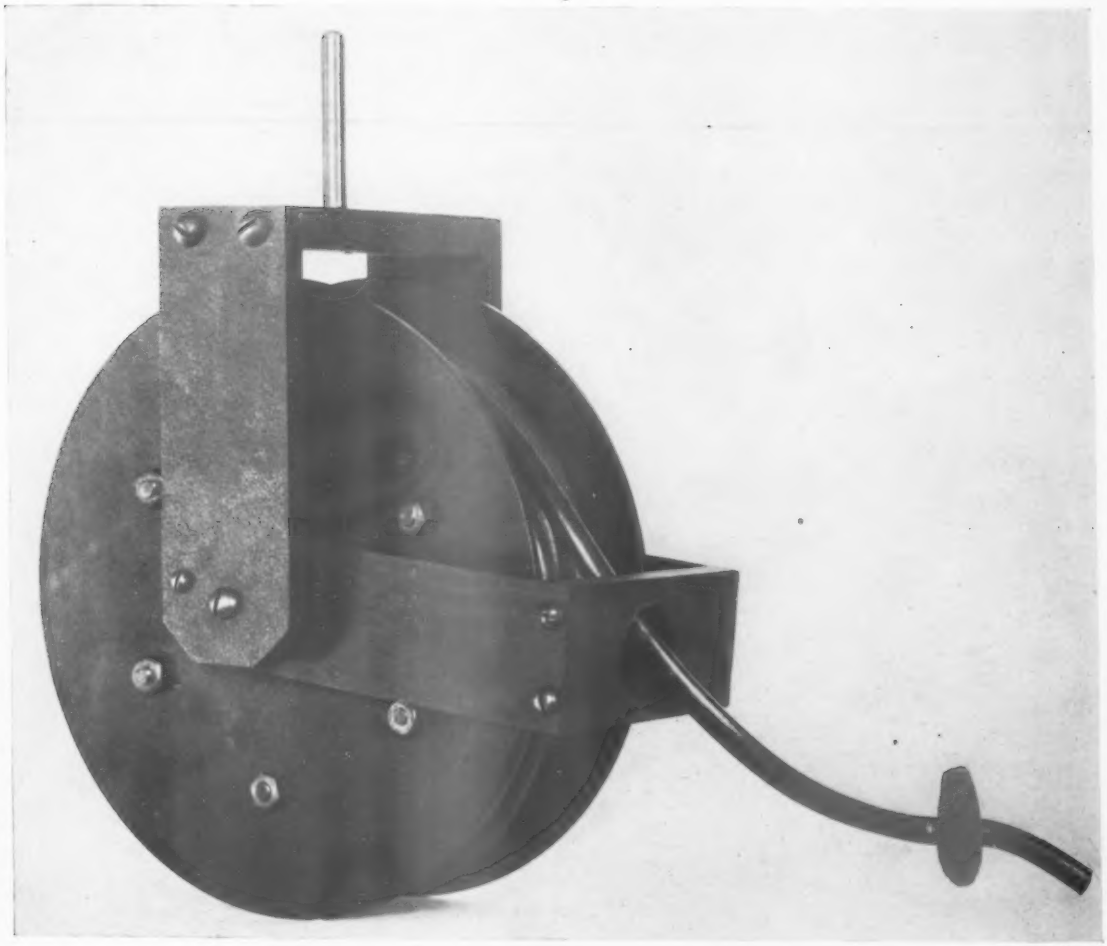


FIG. 5.
The take-up reel.

against the celluloid screen. The patient may be secured to the table by straps. An electric button is pressed which starts the motor, and the whole table may be tilted to any position as shown in Figs. 2 and 3. The fluorescent screen is moved to the proper position by means of a crank and worm wheel which appear at the left of the apparatus. The handle which appears at the right of the apparatus controls the movements of the tube box, while the knobs control the shutters.

FIG. 6.

Details of the take-up mechanism.

VACUUM VALVE TUBE*

BY EUGENE W. CALDWELL, B.S., M.D.

THIS valve tube is provided with a cathode which is so arranged to co-act with an operating regulating device as to automatically regulate the vacuum of the valve tube during operation.

The diagrams here shown illustrate the tube. Fig. 1 is a vertical section. Fig. 2 is a diagram showing a somewhat modified form of circuit connected to the tube. Fig. 3 shows still a different form of circuit.

As shown, the cathode terminal is the lower end of the tube in all the figures. The cathode itself is composed of a number of electrically connected aluminum strips.

The effectiveness and efficiency of this valve action is promoted by the use of a cathode having a large effective diameter or capacity, and a highly desirable regulating action is secured by arranging the gas generating material or salt in a separate regulating chamber having a suitable regulating diaphragm between it and the cathode chamber of the valve tube. When the tube is in normal operating position, the gas generating material in this regulating chamber is more or less in contact with the regulating diaphragm so as to cause the evolution of gas and consequent regulating action whenever the tube gets into the regulating condition. This causes heating effects on the regulating diaphragm or other exposed parts of the regulating chamber so that the tube is promptly restored to its normal critical condition in which such regulating action is eminent but no longer actually takes place. The valve tube, for some purposes, may with advantage also be provided with a plurality of separated anodes so that they may simultaneously be connected to different sources of potential which may be out of phase with each other, so as to combine in a single tube the current impulses from these different sources of electricity.

With a vacuum tube of this character having a main cathode chamber about two and three-quarter inches in internal diameter and about six inches in length, the valve action was very pronounced and the

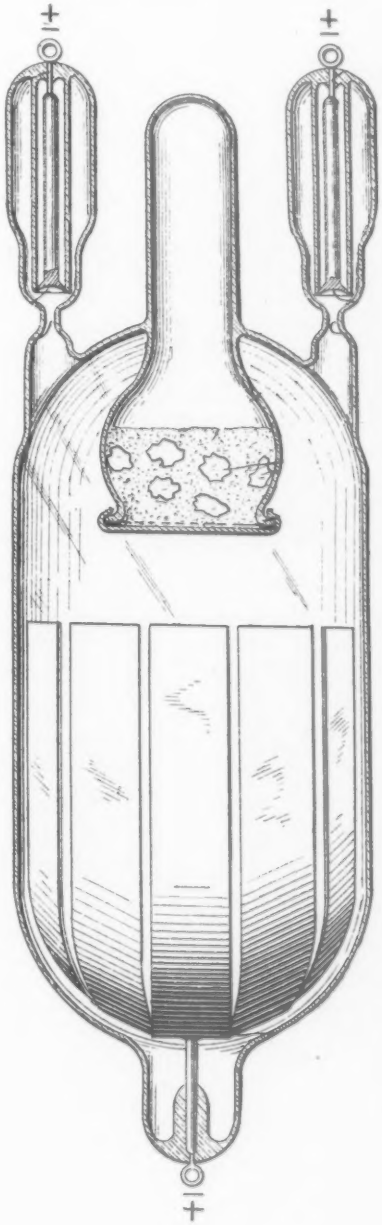


FIG. 1.

* This article was compiled from notes, sketches, and other references [EDITOR].

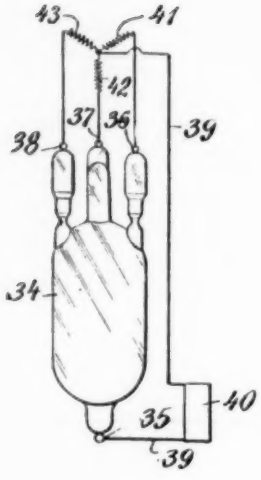


FIG. 2.

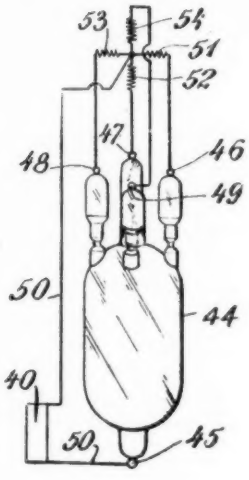


FIG. 3.

direct resistance of the tube was found to be very low, so as to give the tube a correspondingly high working efficiency. The potential required to break down the starting resistance in the direction of the normal operation of the tube was in the neighborhood of 1,000 volts, while a potential of about 30,000 to 40,000 volts was required to overcome the starting resistance of the tube in the reverse direction. By using multiple separated anodes in such valve tubes, each anode may be connected to a separate source of polyphase high potential electricity, so as to allow periodic current impulses to pass through the tube in the desired direction and superimpose through a single tube current impulses from a number of branches of a polyphase circuit. Fig. 2 diagrammatically shows such an arrangement, tube 34 being provided with the cathode terminal 35 and three separated anode terminals 36, 37, and 38, each connected to one of the branches 41, 42, and 43 of a three-phase high potential circuit with the neutral point connected to the working circuit 39, by which the working device 40, such as an *x*-ray apparatus, for example, is connected to the cathode terminal 35.

Fig. 3 diagrammatically shows a four-phase arrangement in which tube 44 is provided with the cathode terminal 45 and the terminals 46, 47, 48, and 49 connected to the separated anodes within the tube, which are not shown. A four-phase high potential circuit of any description may have its branches 51, 52, 53, and 54 each connected to one of the anode terminals, while the mid or neutral point of the four-phase circuit may be connected to the working circuit 50, including a similar utilizing device as 40.

SKIAGRAPHY OF THE ACCESSORY SINUSES OF THE NOSE*

BY EUGENE W. CALDWELL, B.S., M.D.

NEW YORK

THE use of the roentgen ray as an aid to diagnosis in certain diseases of the accessory sinuses of the nose was brought to my attention a little over two years ago by Dr. Coakley, of New York, and Dr. Ard, of Newark. Dr. Ard had just returned from the clinic of Dr. Killion at Freiberg, and had brought with him some excellent plates, in which the outlines of frontal and maxillary sinuses and the ethmoid cells were distinctly shown. On one of these plates there was an increased density of shadow over one of the frontal sinuses, which was believed to indicate pus in the cavity.

There is, in different individuals, such wide variation in the size of the frontal sinuses, in the number and position of their septa, and occasionally such a great lack of symmetry, that the use of the roentgen-ray in this region would be fully justified even if it could give us no other information than the anatomical details just mentioned.

Therefore, at the suggestion of Dr. Coakley, I at once began making roentgenographs of cases from his clinic at the University and Bellevue Hospital Medical College. To this clinic and to the anatomical department of the college I am indebted for splendid material for a series of experiments which were directed toward securing a good technique for making roentgenographs of such cases, and for determining their practical utility to the rhinologist.

This work was carried on at the Edward N. Gibbs Memorial *X*-Ray Laboratory, which is the Roentgen Ray department of the college.

By comparing the frontal sinuses of several cadavers with the roentgenographs made of them, it was readily shown that the extent of the sinuses and the location of their septa could be determined by the roentgen-ray with sufficient accuracy for the purpose of the surgeon. The indications given by the roentgen-ray of diseased conditions in the sinuses of patients from the clinic were confirmed in many cases by operation and by other means, but it seemed desirable to make further experiments to determine why the roentgen-ray indicated such conditions and how much reliance could be placed in these conditions. Some experiments with this end in view were therefore carried out by Dr. Chisholm and myself.

It seemed probable that the increased density of the shadows of diseased sinuses was due chiefly to an increase in the amount of fluid in the cavity, either in a swollen and edematous lining membrane or a collection of exudate or pus. Radiographs of specimens of pus and exudates from various sources show that their opacity to roentgen-rays was practically the same as that of a normal saline solution, or of pure water. This was determined by radiographing at the same time equal volumes of the various fluids in little thin celluloid dishes of exactly the same size and shape.

A piece of mucous membrane from a cadaver was cut in half. One piece was kept moist by placing it in a sealed jar while the other piece was dried. The radiograph of the two pieces showed that the water in the moist specimen cast a shadow many times as dense as that cast by the solids of the dry specimen.

We then made radiographs of some heads of cadavers before and after filling parts of the sinus cavities with water or with pieces of moist mucous membrane introduced through trephine openings. It was easy to detect the added liquid and membrane in the radiograph, but the

* Read by invitation before the Seventh Annual Meeting of the American Roentgen Ray Society at Niagara Falls, N. Y., August 29 to 31, 1906. Reprinted from the *American Quarterly of Roentgenology*, January, 1907.

rather large trephine openings were objectionable and it was found very difficult to keep the liquid from leaking out of the cavities. Dr. Coakley then made the very practical suggestion that we use moist gelatin instead of water or membrane for filling the cavities, and the demonstration was then repeated with more refinement in detail. Control radiographs were first made to show that the opacity to roentgen-ray of the moist gelatin was practically the same as that of the water or pus or edematous membrane.

Radiographs of the heads of some fresh cadavers were made. Then the scalp was turned down over the frontal bone until the supraorbital ridges were exposed. By means of tracings from the first radiographs, the frontal sinuses and their septa were outlined in ink on the frontal bones of the cadavers. Then by using a small drill, directed downward and backward from points above the superior limit of the sinus, we were able to enter unerringly the different cavities formed by the septa. By means of a small syringe needle introduced through the drill holes, we were able to show that these cavities contained no fluid. We then injected into some of the cavities gelatin which was just warm enough to flow through the syringe needle, and which solidified immediately after. The scalp was then replaced and more radiographs of the head were made. In these radiographs the empty cavities could be readily distinguished from those filled with gelatin.

These experiments convinced us that the roentgen-ray indication of fluid in the sinuses was fairly reliable,—a fact which had been recognized by our German colleagues before we began our experiments.

In order to use the roentgen-ray successfully for exploring the accessory sinuses of the nose, it is necessary to obtain radiographs of very good quality. Such radiographs are not easy to make. They call for the best possible appliances, and an amount of attention to petty details of technique which the busy clinician is unable or unwilling to give, and of which he has usually not the vaguest idea.

Owing to the thickness and opacity of the skull and brain, it is necessary to make long exposures, and to use rays of rather high penetration. The use of rays of too high penetration, however, results in a lack of contrast in the negative. Rays of low penetration act more energetically upon the scalp, and longer exposures are necessary with them, in order to obtain sufficient effect upon the photographic plate. Unnecessarily long exposures must be avoided, because they increase the liability of blurred pictures due to movements of the subject, and also because they increase the danger of harmful effects of the rays, both upon the scalp and upon the deeper structures.

The necessity for long exposures, and sometimes for repeated exposure, together with failure to secure the proper degree of penetration and sufficient distance between tube and scalp, sometimes cause roentgen-ray alopecia, and even roentgen-ray dermatitis over the back of the head. Not only these unfortunate accidents, but also the disclosures of Dr. Edsall, of Philadelphia, and others, as to the profound effect of roentgen-rays upon all living cells, remind us of the importance of working with especial caution and certainty in this region. Indeed, I think it is unwise to expose the same individual during a period of three weeks, for a longer time than is necessary to obtain two or three radiographs in the anteroposterior position.

The danger of roentgen-ray alopecia and dermatitis may be considerably reduced by interposing between the tube and the patient some sort of protective ray filter. For this purpose, I use a sheet of aluminum, $^1/_{50}$ of an inch thick, very close to the tube, and work with the target of the tube 18 inches from the center of the plate. No accidents have occurred in my practice under these conditions.

It is, of course, necessary to use some screening device to cut off as much as

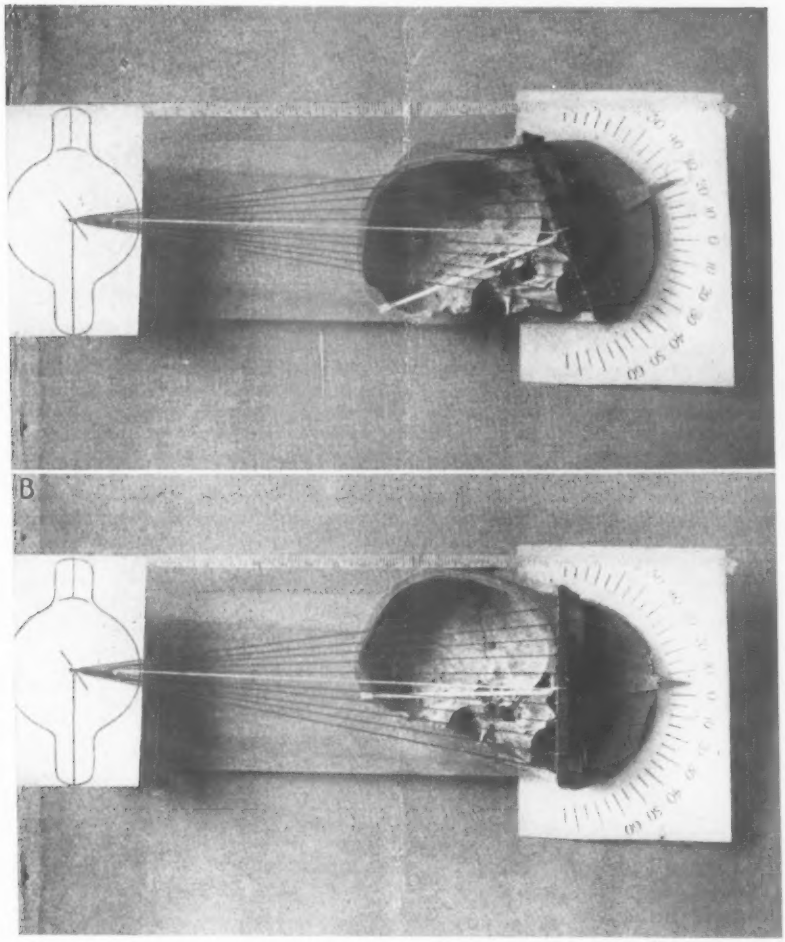


FIG. 1.

possible the rays originating from the glass walls of the tube. For this reason, most operators use the Albers-Schoenberg compression screen, or some modification of it. These appliances, although exceedingly clumsy, are perhaps the best for the purpose which the market affords.

The usual procedure is to place the patient in a recumbent position, face downward, with his forehead and nose resting upon the plate holder, and to adjust the tubular part of the compression apparatus over the back of the head. The usual length of exposure in Germany is two to three minutes, but it is quite possible, with good apparatus, to obtain brilliant negatives with exposures of ten to twenty-five seconds.

The length of exposure, and the degree of penetration depend somewhat upon the thickness of the skull, which varies greatly in different individuals. For determining the degree of penetration of the ray, and for estimating the length of exposure necessary in a given case, I like to observe the degree of fluorescence produced on a barium platinum-cyanide screen by the roentgen-rays which pass through the skull of the subject at the time the exposure is made. This is one reason why I do not use the Albers-Schoenberg apparatus. I work with my patient lying face up on a canvas stretcher. I place the tube and diaphragm under the stretcher, support the plate over the face, place a fluorescent screen over the plate, darken the room, and watch the effect of

the rays on the screen. Two advantages of this method will be apparent at once. The patient is more comfortable, and hence less likely to move during the exposure, and then, if the penetration of the tube changes and becomes too high or too low, it will become apparent at once to the operator, and the exposure may be terminated without delay.

The appearance of a radiograph of the face and its usefulness in diagnosis depend much upon the position of the tube and the direction of the rays with reference to the base of the skull. We must avoid superimposing the shadow of the horizontal plate of the frontal bone upon that of the frontal sinus, or the shadows of the petrous bones upon those of the maxillary sinuses, or the shadow of the basilar process of the occipital bone upon that of the ethmoid cells. Any of these undesirable results and some others as well may occur if the exposure is made in a careless manner. The necessity for a standard distance and position of tube is, therefore, apparent.

The direction of the rays with reference to the plane of the photographic plate is comparatively unimportant, and since we must bring the plate as close as possible to the face, this direction will be determined by the prominence of nose and forehead, and therefore subject to considerable variation with different individuals.

The distance of the source of roentgen-ray (the target of the tube) from the face and the plate is, however, of some importance, partly because upon it depends the amount of divergence of the rays which give us the shadow picture. Considerations of safety to the patient and length of exposure are, however, the chief factors which determine this distance. I find that 18 inches answers all the requirements for safety and that this distance does not necessitate longer exposure than about 20 seconds for the antero-posterior projection and 10 seconds for the transverse projection.

In order to secure a standard position for the source of rays we may select one of the diverging rays which produce the picture and measure the angle which it makes with a plane corresponding approximately to the base of the skull. The ray I have selected for this purpose is the ray which passes through the skull in the mesial plane and pierces the center of the glabella. This ray I have called for convenience the principal ray. A suitable plane which can be readily located by external landmarks is the one which passes through the centers of the external auricular orifices and the center of the glabella. To save time I shall call this plane the basal plane and the angle between it and the principal ray, the principal angle. With a fixed distance between the target of the tube and the glabella the general direction of the rays may be expressed by the measurement in degrees of the principal angle.

From measurements of a number of skulls which had been split in the median plane, and from a number of radiographs of skulls and heads at different measured angles I have found that, with the target 18 inches from the plate at the glabella, the best results are obtained when the principal ray makes an angle of from twenty-three to twenty-eight degrees with the basal plane. I have therefore adopted twenty-five degrees as the standard angle for the principal ray, and the basal plane, or the standard principal angle. With this distance of tube and direction of ray, the shadow of the edge of the horizontal plate of the frontal bone, where it joins the wings of the sphenoid, appears as a transverse line passing across the orbit about one-half inch below the supra-orbital ridges. The appearance, in a symmetrical picture, of this shadow in the position mentioned is a fair indication that the principal angle is approximately correct. I regret to say that some of the plates I shall show here were made before the importance of this angle was appreciated, and before we had accurate means for adjusting it.

A few degrees variation from this standard direction is unimportant, but

accuracy and uniformity are desirable. In order to obtain a fair degree of accuracy, I have arranged my tube with an indicator of transparent celluloid which locates the principal ray, and a scale graduated in degrees, which shows the angle between the principal ray and the perpendicular.

I have also a little instrument which measures approximately the angle of the basal plane with the perpendicular (see Fig. 2). This device carries a conical plug, which fits into the external auricular orifice, and a ruled celluloid strip which can be adjusted so that the ruled line passes over the center of the glabella and therefore lies in the basal plane. A scale, graduated in degrees, to which is attached a spirit level, may be turned until the zero point on the scale is perpendicular. In this position, one of the little pointers indicates the angle of the basal plane with the perpendicular, and the second pointer, placed twenty-five degrees away, indicates on the scale the correct angle for adjusting the tube holder.

With the Albers-Schoenberg apparatus, the same result may be obtained approximately by placing the tubular diaphragm in such a direction that its axis lies in the plane passing through the glabella, and about three-quarters of an inch below the parietal eminences on each side. It is understood, of course, that in making the anteroposterior projection the principal ray, or the axis of the Albers-Schoenberg cylinder, lies in the median plane of the body.

The radiograph of the head in the transverse direction is comparatively easy to make, and is of little importance. It gives an idea of the depth of the frontal sinus, and a knowledge of this depth is sometimes useful in interpreting the shadows on a so-called "front view" plate. The outline of the sphenoidal cells may be shown in the lateral projection, but I am told that this is of little use to the surgeon. I therefore make this plate with especial reference to the frontal sinus. The plate is supported parallel to the median plane, and the ray passing through the center of the glabella

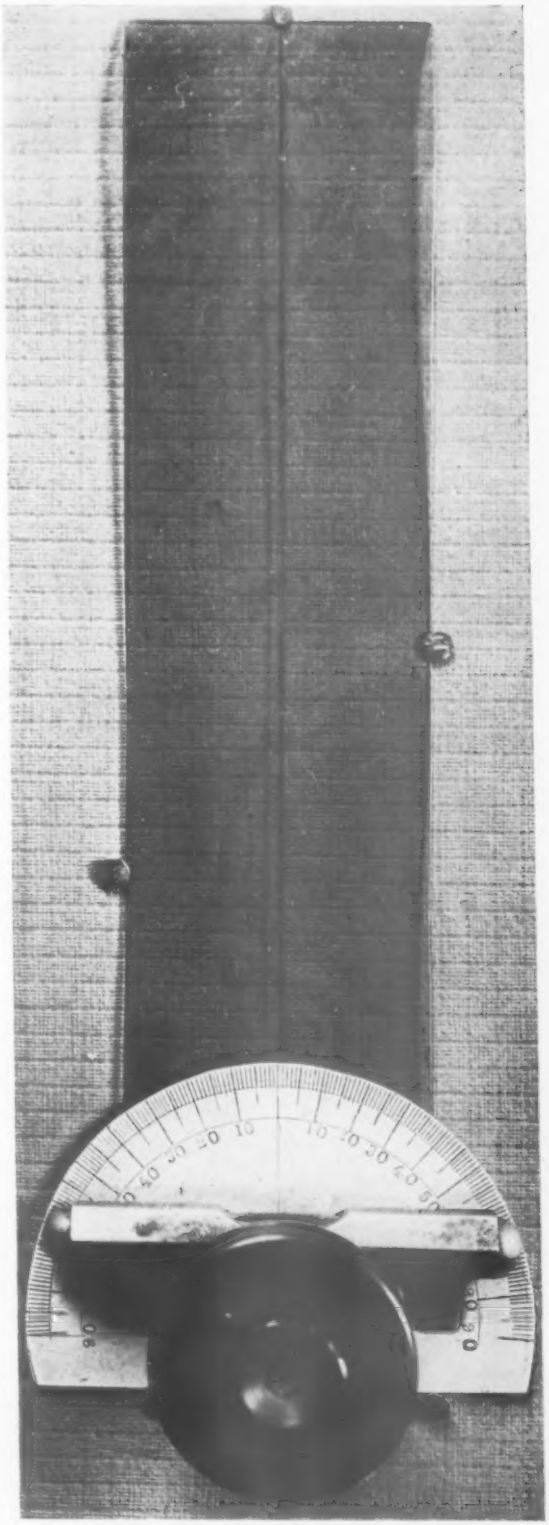


FIG. 2.

is perpendicular to the plate. The sphenoidal cells may be best shown by passing the perpendicular ray through the middle of the line joining the external auricular orifice and the external angular process.

It is well known that photographic prints of roentgen-ray plates fail to show the detail of the original negative. This is especially true of plates of the skull. In these sinus plates, the print is particularly disappointing, and we rely solely upon the negative. Contact copies on glass are difficult to make, and they seldom show as much as the original negative.

The examination of these negatives is facilitated by having a dark mat around the part of the picture we want to see. I therefore make these radiographs on plates eight by ten inches, and have devised a method of giving them a very dense black border, which is as follows: After the exposure is made, I cover the plate with a piece of cardboard the exact size of the plate holder. This cardboard carries at its center a sheet of lead of sufficient size to cover the useful part of the picture, and carries also the words "right" and "left" with the plate number in lead letters and figures. An exposure to roentgen-ray of about three seconds through this cardboard and lead, produces in the developed plate a dense black border around the useful part of the picture, which has been protected by the lead plate, and leaves the indicating words and figures on the plate in the proper position. The appearance of the black border in the developing tray is found to assist materially in examining the plate by ruby light to determine the stage of development.

CANCELLATION OF APPEAL FOR SCRAP PLATINUM

THE Platinum Section and the Section of Medical Industry, War Industries Board, desire to express appreciation of the hearty response made by physicians, dentists and others when the call for scrap platinum was made.

As the Governmental demand for platinum in the making of explosives, etc., has been tremendously decreased by the curtailed war program, it is requested that no further scrap platinum be tendered to the Government through the channels indicated in our communication of September 17, 1918.

(SIGNED)

CHARLES H. CONNER, Chief,
Platinum Section.

LIEUT. COL. F. F. SIMPSON, M.C., U.S.A.,
Chief of Section of Medical Industry.

EUGENE WILSON CALDWELL

1870-1918

EUGENE WILSON CALDWELL, scientist, physician, Nestor of American roentgenology, died June 20, 1918, in the most fruitful period of his life, as the result of injuries received while experimenting with the roentgen ray in the early days of his professional career.

He was the son of W. W. Caldwell and Camilla Kellogg Caldwell. He was born at Savannah, Mo., in 1870. A few years later the family moved to Concordia, Kansas, where they still reside.

As a child, he never cared for the ordinary pastimes of children. On the contrary his interest was always centered in scientific apparatus, and in descriptions of mechanical devices. At the age of eight years he dismantled his mother's new sewing machine, but promptly reassembled it. At the age of ten he constructed an induction coil which, in later life, was one of his proudest possessions. When he was seventeen, he entered the University of Kansas in the electrical engineering department. Shortly after his arrival there he visited the various laboratories and the University museum to see whether all of the apparatus, which he had seen illustrated in his catalogues, really existed. In his second year he was appointed assistant in the laboratory of physics. He took little or no interest in athletics.

While a student at the University he became associated with Professor Lucien I. Blake in submarine telephony experiments, which were first conducted at Woodshole, Mass., and, later, at Sandy Hook Lightship. Together they solved the secret. Professor Blake ungrudgingly gave his assistant full credit for valuable aid. The first message was transmitted between Sandy Hook lightship and Sandy Hook. The instrument at that time was known as the "Hydrophone."

Shortly after his graduation from the University of Kansas, in 1892, he came to New York and on account of his work in submarine telephony he became associated with the New York Telephone Company.

In the early days of roentgenology, it was exploited by photographers, instrument dealers, etc. A photographer who had not met with much success in his business venture offered his apparatus for sale. This was bought by Caldwell in the fall of 1898. The equipment consisted of an oil immersion coil, a General Electric tube and several other accessories. The outfit was demonstrated to him during the day. Possession was taken that same evening and when he tried out the apparatus he found that the coil had been burned out in the interim. He spent that night in repairing his coil, and was rewarded by seeing two patients the next day. Early in his career in roentgenology he recognized it as a medical specialty. Accordingly he began his medical education with a special course in anatomy at Columbia University. This was followed by a medical course and he was graduated from the University and Bellevue Hospital Medical College in 1905.

The Edward N. Gibbs Memorial *X*-ray Laboratory was established in 1901 with Caldwell as director. This post he retained until 1908.

For long years he maintained a shop in connection with his office, so that he might give full play to his mechanical genius. In it were made most of the instruments which were used in his office. These included many of the accessories, from a simple tube stand to a stereofluoroscope. He devised the Caldwell electrolytic interrupter, an induction coil, various types of *x*-ray tubes and a self-regulating valve tube. Early in his career he saw the advantage of the osmosis regulator and we find a description of it in a letter written to the Edison Company, dated 1899.

He is best remembered for his contribution to medical literature on the roent-

gen examination of the accessory nasal sinuses, and for a book which he wrote in collaboration with Dr. Wm. A. Pusey entitled "Roentgen Rays in Therapeutics and Diagnosis."

He was one of the first roentgenologists to join the old Medical Reserve Corps. He retained his membership when the Corps was reorganized at the beginning of the war, and was commissioned as captain in the Medical Reserve Corps, U. S. A. Later, he was advanced to the rank of major.

He was visiting physician to the Roentgen Department of the Presbyterian Hospital. He was also consulting roentgenologist to the New York Orthopædic Hospital and the German Hospital.

He was an Associate in Roentgenology, College of Physicians and Surgeons, Columbia University. He was a member of the New York Electric Society, American Institute of Electrical Engineers, Roentgen Society of London, American Roentgen Ray Society, New York Roentgen Ray Society, Philadelphia Roentgen Ray Society, American Medical Association, N. Y. Academy of Medicine, Phi Kappa Psi, Sigma Psi, and Nu Sigma Nu fraternities.

He was married to Elizabeth Perkins in 1913, who survives him.

AEROPHAGIA

Piedrahita says that the repeated movements of swallowing, the belching of gases, followed by transient relief, and the gurgling sound heard on auscultation of the cardia, aid in revealing aerophagia as the cause of certain disturbances in the stomach, heart and air passages. If the eructation is done facing the flame of a candle, the flame does not waver as it does when fermentation gases are expelled. Three unusually inveterate cases are described in men from 50 to 64 years old, whose incessant but unsuspected aerophagia had caused dilation of the stomach with consequent displacement of other organs, with symptoms that had annoyed them for twenty years. The men were enlightened as to their unconscious swallowing of air as they swallowed their saliva, and were instructed how to avoid it. The most effectual means for this is to place a cork between the teeth for fifteen minutes at a time, especially after meals. With a cork between the teeth it is impossible to swallow, and the men soon conquered their aerophagia habit and with it subsided all their symptoms. Piedrahita says that this habit of swallowing air is often an actual tic, and it seems to be responsible for 10 to 15 per cent. of the cases of digestive disturbances encountered at Bogota. This dilatation of the stomach stretches its walls and smooths out the folds which shelter the secreting glands, and, besides this, the pressure on surrounding organs may induce dyspnea, intracranial oppression and sensory phenomena, unconsciousness and dizziness. He advises carrying a cork in the pocket and putting it between the teeth when the impulse comes to swallow. If there is a tendency to hyperacidity, he supplements this with alkalines and sedatives to soothe the irritated glands in the stomach. By these means excessive production of saliva is prevented, which aids further in checking the swallowing of air.—(*Repertorio de Medicina y Cirugia, Bogota*, June, 1918, p. 461.) (Ref. *Jour. Am. Med. Assn.*, Vol. 71, No. 11.)

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EUGENE WILSON CALDWELL

Again are we called to mourn the loss of a pioneer in roentgenology. Most truly a sacrifice to the pursuit of knowledge and its application to human needs, Dr. Caldwell was one of the first in this country to recognize the prospective value of Roentgen's discovery. He entered this field of investigation with unusual preparation and with a whole-hearted enthusiasm characteristic of the true spirit of scientific research. Neither difficulty nor expense, neither weariness nor danger could ever deter him from carrying on his experimental work in order to achieve the end in view.

To give a complete list of his contributions to the real advancement of roentgenology in this country would be impossible in the space available. In fact, it would, to a large degree, be a history of the development of this work in the United States. Beginning with the redesign of induction coils, following with improvements in interrupters, for many years he continued to develop apparatus, which formed the basis for much of the important equipment now in use, even though not adopted in the exact form of his original development. Dr. Caldwell possessed in a rare degree that prerequisite for research and invention sometimes designated "scientific imagination." There was always in his mind the idea of improvement. He never allowed himself to use the term "good enough," and this applied not only to his mechanical and electrical design, but also to his care in the study of diagnostic problems. His geometrical sense, his intuitive grasp of the problems of function in the human mechanism was fully as remarkable as his genius in basic science and in invention.

Perhaps no one has contributed more to the rational use of fluoroscopy than Dr. Caldwell, and stereoscopic work engaged his attention at an early date. Anticipating military needs, he, at his own expense, developed a stereoscopic fluoroscope for trial. The favorable impression made by the preliminary model led to orders from the Surgeon General to perfect this apparatus. To this task he devoted his last days while suffering intensely, in fact, never free from pain. Almost from his deathbed, on June 17th, he went over many details and urged a close friend to see that the work should be completed.

While his friends, who knew of his sufferings during the latter years of his life,

feel a relief that death has intervened to bring him peace, yet they can only regret the misfortune of his untimely end, far within his threescore years and ten. Many are the problems which had originated in his mind, that he had discussed with a few of his intimate friends, but whose solution must be delayed for lack of one possessing his peculiar training, experience and judgment to continue the work. The roentgenologists and scientists of our country may be proud of this record, and it may be held as an inspiring example to those who desire to contribute to future advancement.

JOHN S. SHEARER.

To many who, perhaps, knew him less intimately, the light of the personality of Eugene Wilson Caldwell was dim in comparison with his brilliancy as a scientist. Accentuating this was a natural reticence concerning matters not essentially germane to his professional activity; consequently only those closest to him could realize the profundity of his sensibility to the beauties of nature and the finer arts of man. Particularly was he a lover of life as revealed in its simple and fundamental surroundings—the domestic life of living creatures. He often expressed a yearning for an oasis in the journey of labor, where he might pause long enough to enjoy these things. Of the fine arts he was strongly appreciative; his knowledge of the textiles of the East was authoritative.

Major Caldwell took especial delight in his intercourse with his friends, and he thoroughly enjoyed the deep and lasting associations which only his personality could create and develop. He was an amazingly accurate judge of human nature; therefore an able and just critic. The encouragement of his praise has many times proven a potent stimulation to others in their work. His advice was never sought in vain.

The acute sense of humor with which he was blessed helped to mitigate the suffering of his later years and to protect an active mind from the influence of corporal anguish. The familiar shaking of his body in silent laughter was never stayed by physical distress.

Those who cherish the welfare of American roentgenology will regret the loss of Eugene Caldwell. Those who learned to know him heart and soul will ever mourn it.

PERCY BROWN.

Major Eugene W. Caldwell was a member of the old Medical Reserve Corps of the United States Army, having been commissioned as a captain in that Corps long before the war. Upon the entrance of the United States into the war, he accepted a commission as captain in the Medical Officers Reserve Corps and, soon after, was ordered to active duty and assigned to station in New York City for the definite work of perfecting a stereofluoroscope for the use of the Medical Department of the Army. He was promoted to the grade of Major in the Medical Reserve Corps on May 11, 1918.

During the last year of his life Major Caldwell worked almost continuously, in spite of great physical suffering, to bring to completion what is undoubtedly his greatest achievement, the stereofluoroscope. Even during his last illness, while confined to bed, and in the midst of great pain, he was able to give such advice as to bring this apparatus to a high state of practical efficiency. The first stereofluoroscope is now ready for shipment to France.

It was a great satisfaction to Major Caldwell, and is now a source of pride and comfort to his many friends, that he was able to bring this important work to completion. It is confidently believed that the stereofluoroscope will be of exceedingly great value in roentgenology, and especially in roentgenology as applied to conditions in military hospitals. But however valuable it may become, it is only one of the many contributions made by Major Caldwell to the advancement of roentgenology, in which he was a pioneer. The Army today owes him a great debt—directly, for the stereofluoroscope and for invaluable advice

in the methods of instruction to be followed and apparatus to be adopted; and, indirectly, for the many contributions made by him to the advancement of roentgenology, from which military roentgenology is profiting today together with roentgenology in general.

Major Caldwell exemplified the highest ideals of the "officer and gentleman," and, although not closely connected with army life, he had in the highest degree those qualities typical of the soldier—devotion to duty and patient endurance of hardship. Army officers who were honored with his friendship have, in the midst of their great sense of personal loss, a feeling of pride in his sterling worth as a man, as well as in his great achievements. They mourn his loss in company with his hosts of other friends. A. C. CHRISTIE.

ADDRESSES DELIVERED AT MEMORIAL SERVICE

Held June 23, 1918

AT CAMPBELL FUNERAL CHURCH, NEW YORK

On occasions of this kind our first thoughts are always directed toward the loss sustained. In this case there is a loss to his family and to his personal friends as well as to the cause of medical science, which can never be replaced. Yet the measure of loss is, after all, the fullness of the life that it represented; and in all that makes for usefulness and progress the life of Dr. Caldwell was full to overflowing. This is not the place, and I am not the one, to attempt to picture the magnitude of his service or the far-reaching scope of his genius in his chosen field. Suffice to say that so long as the science he represents is used by mankind so long must his work endure.

Preëminently a man of high genius and kindly in all his traits, it is, in a way, strange that he should pass away while active in the greatest conflict civilization has known. While I am sure that the pomp and circumstance of the military in the time of peace would have no attraction for a man of his temperament and aims, yet there is something peculiarly fitting in the military connection at this time. As an example of the truest of soldiers, loyal to his country and the cause of humanity, obedient to the call of service, facing suffering and danger without a murmur, carrying through his fight to the bitter end, he was the embodiment of all that is true and noble in the military service. Eugene Caldwell was a hero in all that the word implies, and no word of yours and mine can add to a proper appreciation of his heroic work during these latter years when he was suffering hour by hour.

While his colleagues are sorrowful that his span of life was not prolonged and that the developments springing from his active mind were not completed, they one and all can be sincerely glad of the work he has done; and to his intimate friends who have known him so well, the memory of his aid and kindliness will be with them until they follow at the end. To the younger men his memory and his achievements should be an inspiration throughout their allotted time. J. S. SHEARER.

A great and good man has gone from among us. Others may speak of his achievements in science and invention, of the benefits to the world from his professional accomplishments. I shall speak of him as one of the many who in the privileged and intimate relation of friendship, knew and loved him for his fine and gentle nature.

A sufferer for years and barred by his injuries from many of the more active pleasures of life, he never complained, never showed a trace of bitterness.

He was modest beyond reason as to his own accomplishments, and generous to an extreme in his appreciation of others.

Eugene Caldwell got much out of life, because he put much into it. Kindness begets kindness. Love begets love. He had many friends. He was well loved because he gave so generously of his affection.

I like to think that the staunch faith of his friends, the appreciation of his professional associates, and the love of his family and intimates may have compensated for and eased the sufferings which he endured for so many years.

He was a brave man. Above all he was loyal—loyal to his family, loyal to his profession, to his fraternity, to his country —loyal to the high ideals of early manhood.

A few nights before he passed away, I had my last intimate talk with him. In full realization of his condition and of the slight chance for his recovery, he spoke of many things: a little of his work, a little of great world happenings, a very little of himself, of his weariness and desire for release from pain. But finally, his eyes lighting up in the old brave way, he said, "Don't worry. I'll make the best fight I can."

No words of mine can paint the true character of Eugene Caldwell, nor assuage the grief of his sorrowing family, but mingled with their grief let there be a just pride in the thought that his life was a help to humanity, and an inspiration to others. Faithful to every obligation, he fought the good fight. His work will live after him. His friendship was a joy, his memory a blessing.

LLOYD ATKINSON.

A few of the living many who are honored by having possessed the friendship of Eugene Wilson Caldwell are met here lovingly to dedicate the memory of it. To contemplate this life, now ended, is but to recall the lives of such men and such martyrs who have gone before—the early hardships, the tenacity to an ideal in the face of discouragement, the continued stimulation of labor never ending, for which no adequate earthly reward exists.

During his latter years he appreciated a satisfying requital, not so much from the fact that he was the recognized father of American roentgenology as from the knowledge that it had grown and thriven, in the manner and direction he desired, on the nourishment of his own precept and example.

A patriot in every deed and thought, he planned ceaselessly for the scientific armament of our forces overseas, and the lips that utter these words are privileged in that they were the first to convey to him the certain knowledge that the medical service of our army is the more effective for his contributory influence.

Such glorious sacrifice of self, as exemplified in a life such as his, is too precious a treasure to be shown us for long, and undying Fame jealously snatches it away into her own keeping.

What is Life, dear friends, unless to be enriched for us by this fleeting glimpse we are permitted to obtain? One day the Treasure Chest shall be thrown open to each of us forever.

PERCY BROWN.

We are gathered here this afternoon to pay our tribute to the memory and achievement of a departed friend. Doubtless there are many here who had the privilege of a closer acquaintance with Dr. Caldwell, and a more scientific appreciation and understanding of the technique of his science. To me he was at first a friend's friend, but later when I came to know him better I was glad to claim him as my own friend, a personal friend. My only regret is that I did not know him better and more intimately than was my privilege.

It is said that "they also serve who only stand and wait." How much truer is it of one who like Dr. Caldwell, gave his life both figuratively and literally to the services of his fellowmen. I wish that I were qualified to tell you as some of those present doubtless are, of all the marvelous things which he did, of the discoveries which he made, of the apparatus which he skilfully perfected for the amelioration of

the condition of mankind. Being a layman in his science, I cannot comprehend fully the significance of his accomplishments, but I yield to none in my admiration of the things that he did. As I look about this room and note the number of men clad in khaki, I am impressed by the possibility that many, many men thus arrayed will have reason to be exceedingly grateful for all the pains which he took and the contrivances which he devised, calculated to make their condition more tolerable and to facilitate the work of surgeon and nurse in the restoration of the wounded and injured. I wish that one competent to speak would tell of the marvels which he performed in the pursuit of his particular branch of science.

Our deepest admiration is bestowed upon the man who devotes his whole energy to the unselfish service of his fellowmen, and that admiration reaches its highest pitch when such a man sacrifices himself completely and gives up his life to achieve his purpose. That man wins, and deserves to win, the martyr's crown. Unobtrusively and quietly Dr. Caldwell pursued his course, and now has left a record of achievement, the memory of which is sweet and the reward sure. We honor Dr. Caldwell for all that he did, and we are glad of the privilege of his friendship. Words fail to tell the depth of our sense of loss in his departure.

There are those here who will tell you of what he was to them and to others. One was a fraternity brother, and two were closely associated with him in scientific studies and in the bonds of a common service to a common cause. They had the privilege of close personal acquaintance, and they will speak out of the depth of sorrowing hearts.

J. Frederic Gillette.

Resolutions adopted by the American Roentgen Ray Society

upon the Death of

Major Eugene Wilson Caldwell

WHEREAS: The American Roentgen Ray Society having lost by death its former President and esteemed colleague, Major Eugene Wilson Caldwell,

BE IT RESOLVED: (1) That this Society in convention assembled, herewith expresses its profound sorrow, and as a token of respect, that the Society adjourn.

FURTHERMORE, (2) that these resolutions be spread upon the minutes, and published in the official journal of the Society.

FURTHERMORE, (3) that a copy of these resolutions be transmitted to his family.

BY THE COMMITTEE

F. H. BAETJER
PERCY BROWN
H. M. IMBODEN

A SIMPLIFIED ADAPTATION OF CROSS-SECTION ANATOMICAL LOCALIZATION*

BY EDWARD S. BLAINE, M.D.

Captain, Medical Corps, U. S. Army

CAMP GREENLEAF, GA.

THE interest created by Flint's[1] recent article on the "profundometer" method of foreign object localization has served to stimulate the writer to simplify that more or less complicated procedure in order more conveniently to obtain the same end result. This end result is the graphic depiction of the projectile lying in the precise area in which it lies with regard to the surrounding anatomical structures, thus enabling the surgeon to determine at a glance its orientation and the best route of surgical approach. In a small percentage of cases the value of such graphic orientation is undoubtedly great, particularly in regions of vital structures.

Briefly, the profundometer method consists of obtaining, by fluoroscopic observation, three separate lines, each one passing through the projectile in the body, mark-

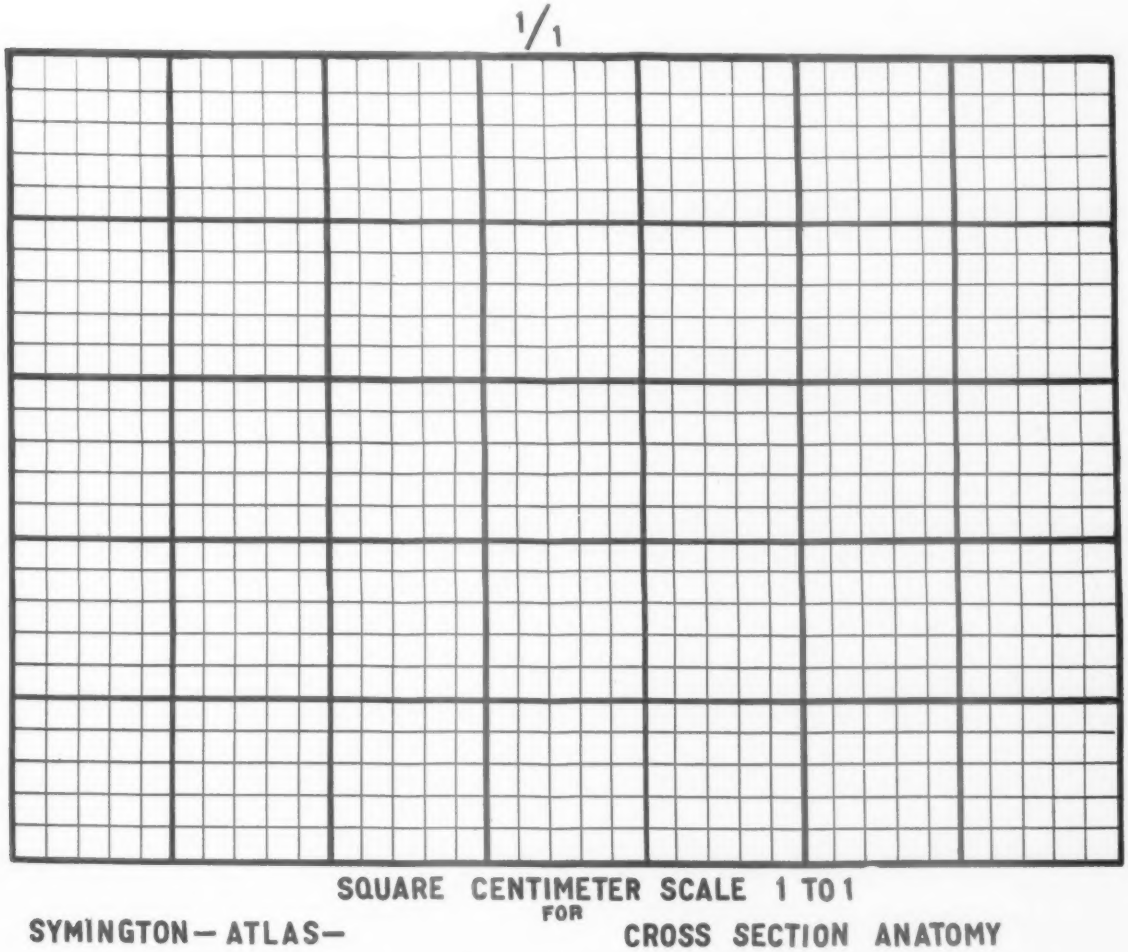

FIG. 1. TRANSPARENT SHEET RULING. EVERY 5TH LINE ACCENTUATED TO FACILITATE COUNTING.

*Read at 19th Annual Meeting of the American Roentgen Ray Society, September, 1918.

ing the points of inlet and outlet of the roentgen-ray on the skin, then wrapping or moulding a hinged metal strip around the circumference of the part, marking the overlap of the ends and transferring to this metal band the six skin marks. The strip is then removed from the patient and selecting that section of the body (from the key figure) upon which the projectile was found to lie and to draw in all the anatomical structures in the outline obtained by the moulded strip. This completes the proceeding and the drawing is ready for the surgeon's use.

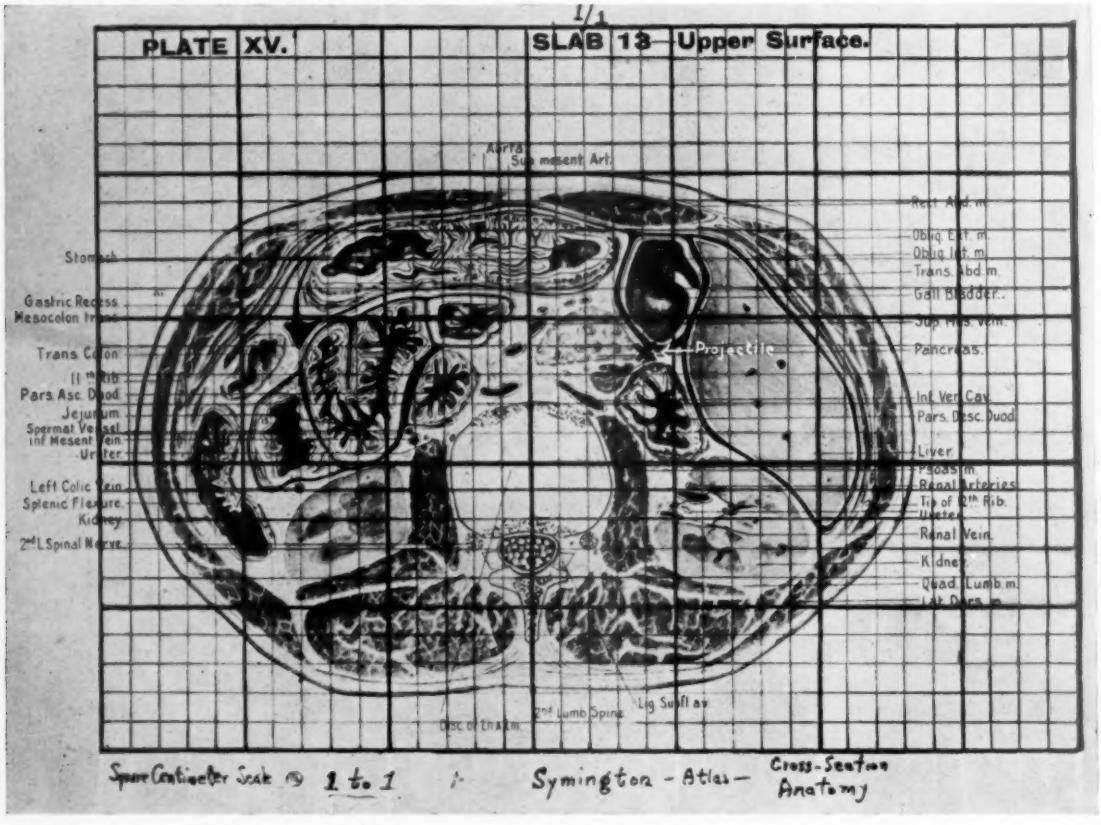

FIG. 2. EXAMPLE NUMBER I.

FOREIGN OBJECT FOUND AT THE UPPER EDGE OF THIRD LUMBAR VERTEBRA.

D = 6. cm.
H = 11.5 cm.
L = 9. cm.
AR + PR = 4 cm.

ANATOMICAL LOCATION: THE PROJECTILE LIES IN CLOSE CONTACT WITH OUTER PORTION OF PANCREAS JUST POSTERIOR TO GALL BLADDER AND INTERNAL TO EDGE OF LIVER, IMMEDIATELY IN FRONT OF DESCENDING DUODENUM.

placed upon a sheet of drawing paper; a pencil is used to mark the shape of this mould and the three pairs of marks are transferred to the paper. Straight lines are drawn between each pair of marks and the point of their crossing indicates the position of the foreign object. It now remains to consult a cross section anatomy or atlas,

In the several steps of this operation difficulties are often encountered. These are: (1) placing the six skin marks indicating the inlet and outlet of the roentgen ray. This, however, can be more or less conveniently done with the aid of the Bowen ring pointers; (2) the difficulty in handling the hinged metal strips provided with the

apparatus which, particularly the larger bands, are likely to get out of shape between moulding and tracing; (3) in spite of great care the three lines often fail to cross at a common point, thus forming a triangle; (4) possible failure of the artist to make allowance for individuals larger or smaller than the average used for the illustration in the atlas and lack of a considerable artistic skill and experience necessary to a correct drawing of the anatomy present.

While the value of this anatomical localization in a few selected cases cannot be questioned, it is not a method for use where speed and time are important factors. The identical end result can be accomplished by a much shorter technic and without the use of the metal strips or the need of a skillful artist.

This is done by fluoroscopically locating the foreign object with the U. S. Army parallax double-ring instrument,[2] obtaining therewith three skin marks at the body level of the projectile. This instrument gives two lines at right angles to each other, each one passing through the projectile and the scales give three skin-pro-

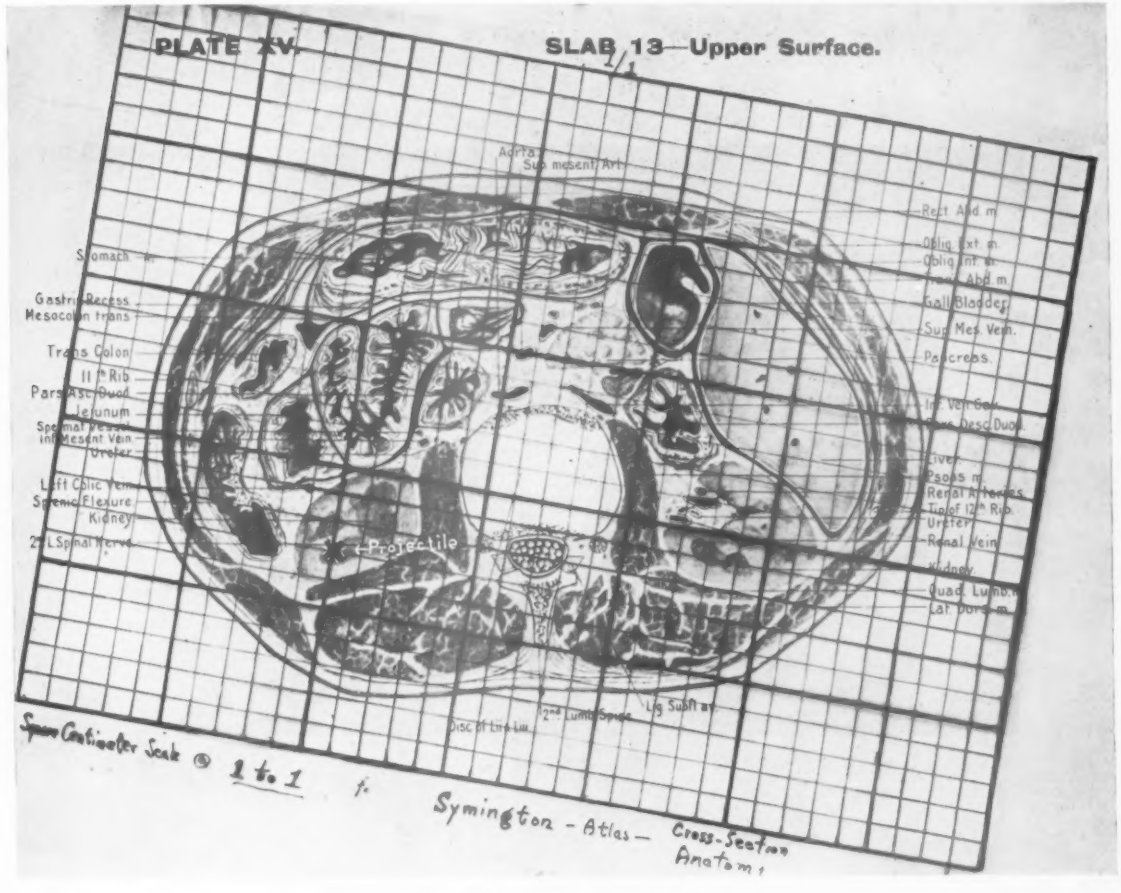

FIG. 3. EXAMPLE NUMBER II.

FOREIGN OBJECT FOUND AT THE LEVEL OF LOWER EDGE OF SECOND LUMBAR VERTEBRA.

D = 13. cm.
H = 4.5 cm.
L = 6.25 cm.
AL = 5 cm.
PL = 8 cm.

ANATOMICAL LOCATION: THE PROJECTILE LIES IN SUBSTANCE OF LEFT KIDNEY, LOWER POLE, POSTERIOR HALF.

jectile distances at one setting. One of the skin marks is anterior, another is posterior, and the third is on the lateral skin surface. Measure and note the distance between the anterior mark and the median line, right or left—if the patient was squarely supine the posterior distance will be the same; but if, for any reason, he could not lie in such position, measure and note the posterior distance. Consult a cross-section atlas, examine the key figure for the body level on which the foreign object lies (noted at time of screen examination), turn to the proper section, and place over the page a transparent sheet which has been ruled in square centimeters, or reductions thereof, according to the atlas used, set the ruled sheet so that its middle line is in the median line of the cross-section illustration, and count the number of centimeters that the anterior (and posterior) skin mark is from the midline of the body. On this line count downward the number of squares that the depth of the projectile was localized below the skin. Check up by noting the lateral and posterior skin foreign object distances. Thus, if the patient be much larger or much smaller than the illustration (average normal subject), proper allowance can readily be made to obtain anatomically correct proportion. This completes the proceeding and the surgeon can see at a glance where the foreign object lies with reference to the surrounding anatomy.

The transparent sheet referred to is best made by washing off the film of an 11 x 14 roentgen-ray film. (See Fig. 1.) The squares may be marked by use of a steel sewing needle and rule. If the atlas used be the "Eyclesheimer-Shoemaker" it will be necessary to make the squares 8 millimeters each as the illustrations in that work are uniformly a $^4/_5$ reduction of a normal individual. If the "Symington" atlas be used the squares will be full centimeters because the charts in this work are life size.

From the foregoing it will be seen that this is a mere additional step to the parallax double-ring method of foreign object localization and takes but a few seconds of time after the three skin marks and distances have been obtained. In the event that the surgeon, or the roentgenologist, desires a graphic record of the case, a simple tracing through thin paper can easily be made by any one of the operating room assistants.

To illustrate by example the application of the above described proceeding let us assume a case in which a projectile was found, on fluoroscopic examination, to lie in the abdomen at the level of the upper edge of the body of the third lumbar vertebra. (See Fig. 2.) It is 6 cm. below the skin mark on the anterior surface, 11.5 cm. from the posterior mark, and 9 cm. from the lateral skin mark. Measurement of the distance of the anterior (and posterior) mark from the median line gives us 4 cm. to the right. On consulting the key figure of the cross section atlas, finding the section of the upper edge of the third lumbar vertebra, turn to that page and place the transparent sheet of ruled squares so that the centre line is on the median line of the illustration. Count 4 squares to the right. On this line the projectile lies. Count 6 squares downward. This is exactly the position of the foreign object. Check up on the other two figures, 11½ squares from posterior edge and 9 squares from the side. Any difference between the dimensions of the patient and the illustration can easily be taken care of by halving the amount of increase or decrease and slipping the sheet of squares to accommodate. Thus 6 (anterior) and 11.5 (posterior) equal 17.5 cm., the thickness of the patient at the level of the third lumbar. This is the same as the illustration so no allowance is needed. But if the thickness of the patient were 19.5 cm., he would be 2 cm. larger than the average used for the illustration and the sheet should be displaced 1 cm. anteriorly and the other 1 cm. posteriorly.

The *x*-ray report of this case will be as follows: "Anatomical localization: a for-

eign object (rifle ball, shrapnel, etc.), lies just posterior to the fundus of the gall bladder, in close proximity to the right edge of the head of the pancreas, internal to the edge of the liver and immediately in front of the descending duodenum."

A second example may be cited to illustrate a different application. In this case the foreign object is found at the lower edge of the second lumbar vertebral body; its depth is 13 cm. from the anterior skin mark, 4.5 cm. from posterior mark, and laterally, 6.25 cm. (See Fig. 3.) The distance from the median line anteriorly is 5 cm. left, and posteriorly left, is 8 cm., because the patient could not lie squarely supine. This requires that the squares be set on the respective distances anteriorly and posteriorly from the median line of the illustration. With this setting we count down on that line 13 squares which gives the precise location of the projectile.

The roentgen-ray report will read "Anatomical localization: the foreign object lies in the lower pole of the left kidney in the posterior position of same."

It will be seen that reports of this explicit nature are far more illuminating to the surgeon than mere figures as to depth, and convey to him a far greater degree of accuracy than is possible by the mathematical calculating methods.

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INOCULATION DAY

My blood the surgeons fortify
With antiseptic serum;
The dread bacilli I defy—
What cause have I to fear 'em?
We form outside the pest-house door
At one o'clock precisely,
But if we get our dose at four
We think we're doing nicely.
And in our arm the surgeon stabs
A hypodermic squirter,
E'en as the hungry hobo jabs
His fork in a frankfurter.
I'm full of dope for smallpox germs,
For typhus and such evils;
For broken heart and army worms,
For chestnut blight and weevils.
I'm doped against the bayonet
Wielded by German demons;
But no one seems to think I'll get
Dear old delirium tremens.

—A Private at Plattsburg, in the *Journal of the A. M. A.*

THE ROENTGEN INSTALLATION OF AN AMERICAN MOBILE HOSPITAL

BY CAPT. JAMES W. SQUIRES, M.R.C.

Roentgenologist to Mobile Hospital No. 39, A.E.F.

ALL roentgenologists will naturally be interested in the roentgen-ray equipment, facilities and problems presented in mobile sanitary formations, which have been adapted from the French Sanitary Service, one of which is now known officially as Mobile Hospital ——. To those who are not familiar with the nature and function of these units, the following extract from a report made by Lieut-Col. Flint to the Medical Department may be of interest:

AUTOCHIR.

"The Mobile Hospital or 'Autochir.' (Ambulance Chirurgicale Automobile) is a development of the old French field hospital, which, both in personnel and equipment, proved inadequate to meet the surgical demands of modern warfare. The conditions imposed by the present military situation required a formation equipped with the technical machinery of a highly organized hospital and operating room; that is to say, an adequate sterilizing and roentgen-ray plant, where a large staff could operate continuously. This, furthermore, had to be coupled with a considerable degree of mobility so as not to immobilize permanently an expensive equipment of this sort, and to allow it to be despatched to any point desired according to the military necessities.

"The earlier attempts of the French resulted in the formation of the Auto Chir., now known as Type 1915, which consisted of all the essential equipment of a modern operating room and *x*-ray room mounted on several trucks.

"The personnel of these units consisted of a staff of highly trained surgeons and roentgenologists, so that the organization in times of attack might operate continuously for periods of twenty-four hours. As organized at present, the staff forms the intensive operating machinery of the French evacuation hospitals or it is attached to field hospitals, used for non-transportable cases.

"Three years of experience with these formations has led to marked improvements in the equipment which was, at first, much too heavy and cumbersome. The saving of space and weight, as is shown in the latest product of the French factories, is the result of many experiments which have achieved reduction in both the number and weight of the cars employed.

"The earlier Autochir. carried only its operating personnel, but the latest type carries ward personnel, sufficient either to care for the most seriously wounded assigned to the unit, or to allow it to functionate as a small independent hospital.

"The recent development in German strategy, resulting in the absolute destruction of the terrain over which their troops retreat, makes it essential to provide some form of mobile hospitalization which can be used temporarily until more permanent hospitals are constructed. This aspect of the hospital problem has resulted in the production of a new Autochir., the so-called Ambulance Chirurgicale Automobile, Type 1917, known in the U. S. service as the Mobile Hospital."

Equipment.—"The equipment can be divided into an operating section and a section of hospitalization. With the unit there are four permanent trucks, on one of which is mounted the sterilizing apparatus and on another the roentgen-ray equipment. The other two cars are ordinary trucks which serve the purpose of carrying supplies from the base or railhead to the point where the mobile hospital is functionating. The organization is provided with a portable operating room

barrack, adequately heated, and with a capacity that permits of two tables being used simultaneously. This barrack is carried on a trailer. A series of Bessoneau tents are employed for wards, each having a capacity of 20 to 25 beds. These wards are connected by a covered corridor. There is likewise a specialized Bessoneau tent, used as a reception and preparation ward for patients until they can be operated upon and hospitalized. The personnel is housed in Bessoneau or Tortoise tents. The latter are also used for offices, laboratory, mess, etc. The capacity of the hospital varies from 100 to 150 beds. Two rolling kitchens of the aviation type are also included in the equipment. With the exception of the portable operating barrack, roentgen-ray and sterilization material, the entire equipment of the hospital is transported by means of ordinary trucks which are temporarily requisitioned when necessity for transportation arises.

The Use of the Autochir.—(a) "In times of an attack at more or less fixed portions of the line, these units can store their hospitalization equipment and, with the addition of extra surgical teams, form the essential operating mechanism of the large evacuation hospitals. It is in this capacity that the Autochir. has operated with the French Army for the past three years.

(b) "In areas where sudden need for hospitals arises, they may be employed with their mobile tentage as small surgical units. Under the same conditions these organizations may follow the troops in an advance, after the roads are repaired, and work independently until more permanent hospitals can be built.

"Under conditions of sudden emergency, such as occurred in Italy last November, these were the only type of surgical hospital which the French had at their disposal. Several of them were attached to the French Army supporting the Italians, and formed their chief surgical units. According to the French standards there are about three such organizations per army corps of four divisions."

THE ROENTGEN-RAY EQUIPMENT OF THE MOBILE HOSPITAL

As practically all battle injuries necessitate the accurate localization of projectiles, much of the efficiency of the Mobile hospital depends on its *x*-ray equipment. Furthermore, as at any time the campaign may become one of movement, it is most important that this equipment should combine mobility and compactness with a maximum of efficiency. The French have met this problem by the introduction of a roentgenological truck possessing the qualities enumerated above. This truck comprises an electrogenic set and a specially designed truck body, which affords ample space for the transportation of the necessary radiological apparatus and accessories. As this equipment has been greatly improved since its introduction, a description of the latest model may prove of interest.

Technical Truck and Electrogenic Set.—This truck consists of a two and one-half ton Renault chassis, an electrogenic set and a specially constructed body. The motor of the truck has two functions, driving the car and operating the electric generator. It is of the four-cylinder, water-cooled type of 35 horse power and has an overland speed of fifteen miles per hour. The speed of the motor is regulated by a governor of the fly-ball type, which is mounted between the motor and the electric generator. This governor is ordinarily set for about 1100 R.P.M., but for use with the generator it is adjusted to give a motor speed of 850 R.P.M., which is maintained automatically at all loads from 0 to 50 amperes. The generator is mounted immediately in front of the motor and is supported by an extension of the chassis frame of the truck. It is compound wound, direct current, rated at 5 K.W. and is direct-connected to the shaft of the motor.

The control board is placed on the dash of the truck and comprises: An irreversible plug for the cable, conveying the current from the generator to the main distribution panel, a voltmeter, an ammeter, a

field rheostat, a double pole main switch, two 60-ampere fuses and a cut-out switch in the field circuit, so that while moving on the road the generator runs idle and functions as a fly-wheel.

Body of the Truck.—The body of the truck is skillfully constructed for the reception of the roentgenological equipment and is used as a developing room and for storage of the excess equipment when the installation is in operation. Lengthwise through the body of the camion runs a central aisle, flanked on either side by drawers, cabinets, and shelves for the storage of the *x*-ray plates, chemicals, and the smaller accessories. The fragile material, such as the *x*-ray tubes and valves, is packed in specially padded wooden boxes. The practicability of the packing is shown by the fact that, while these camions are driven over rough roads, the fragile material is rarely broken. The tube boxes and the larger parts of the apparatus, to be described later, are held in position during transport, in various parts of the truck, by means of leather straps.

The interior of the truck is light tight, yet well ventilated, and fitted at its anterior end with a red glass window, shelves and other accessories for photographic work. For working with artificial light the interior is also fitted with conveniently placed red and white electric lights. Where running water is available, flexible hose connections may be made between the source of supply and the metal tanks for the washing of *x*-ray plates.

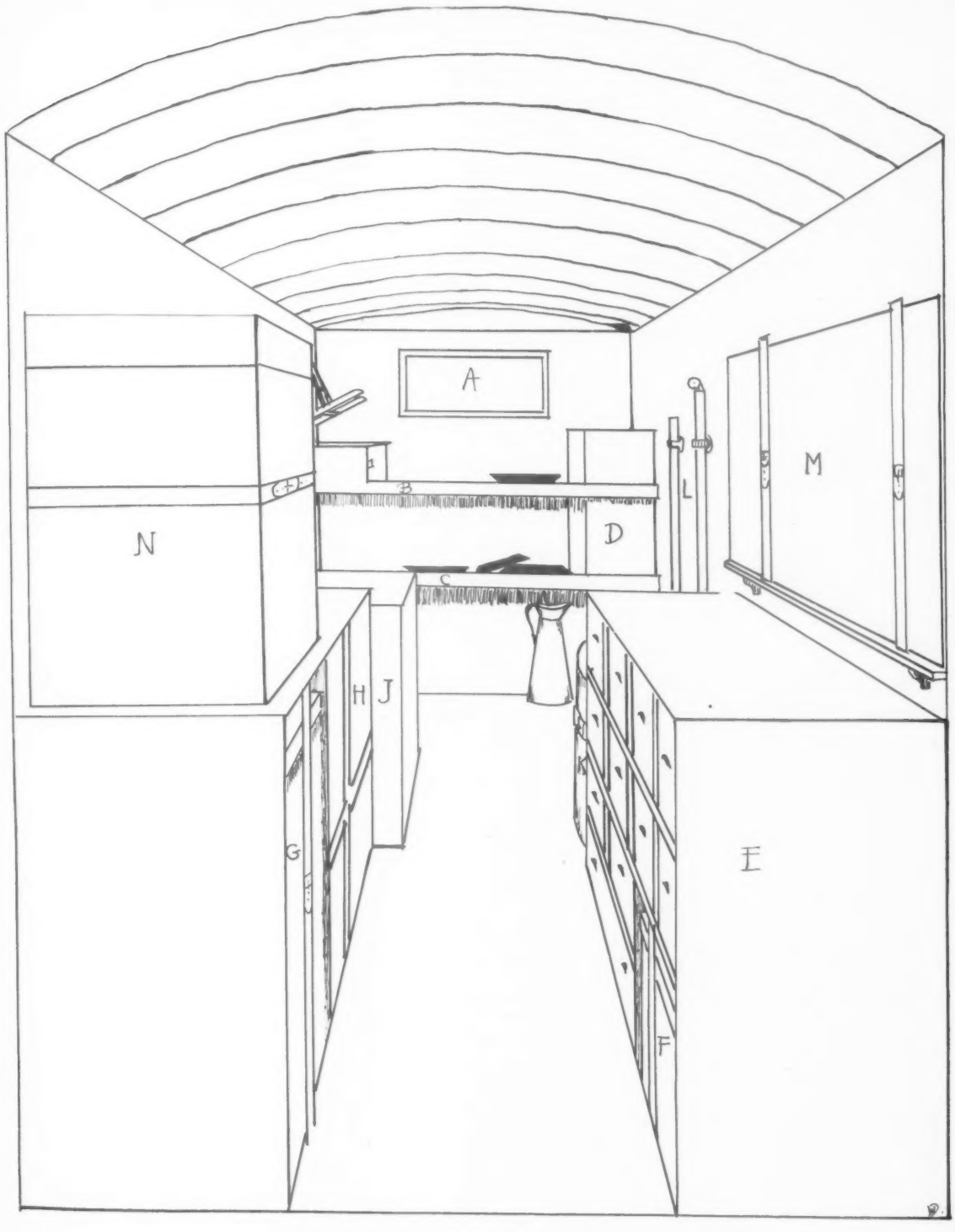
Roentgenological Equipment.—The French Service de Santé furnishes with the equipment the Chabaud and the Pilon roentgen-ray tubes and the Villard and Pilon valves. These require considerable regulation to maintain their proper vacuum. This unsatisfactory feature has been eliminated in our equipment by adapting the Coolidge tube installation to the French equipment. The Coolidge filament is heated by means of a 60 ampere hour, 12 volt storage battery which can be recharged as often as is necessary. On the main distribution board of the electrical equipment of the hospital there is a bank of lamps for charging the *x*-ray battery. We have simplified this procedure by placing a bank of lamps in the roentgen-ray room, thus rendering it unnecessary to move the storage battery for recharging.

The Gaiffe-Gallot *x*-ray table, which is supplied with this equipment, is a plain wooden table, seventy centimeters in width, and two meters in length. The top of the table is one centimeter thick. The table is fitted with folding legs which are clamped in position by means of set screws.

The tube stand, Drault model, small type, is separate from the table and runs on a small track placed on the floor. It is assembled by placing the upright rod on the stand base, then attaching the tube holder and cupule to the upright rod and adjusting the counter balance. The tube stand is small and compactly built, its weight being about seventy-five pounds. It is graduated in centimeters for vertical and horizontal tube shifts. The horizontal arm support of the cupule is arranged with a collar so that it can be rotated 26 degrees for the 26 degree method of localization.

The remaining important elements of the roentgenological equipment are divided into two units, the mobile roentgeno-surgical transformer unit of Ledoux-Lebard and a fluoroscopic operating unit and its accessories.

Mobile "Radio-surgical Unit" of Ledoux-Lebard.—The Ledoux-Lebard transformer and its accessories are enclosed in a nicely finished wooden case, mounted on rollers. The unit comprises a transformer, autonomous mercury interrupter, a condenser, spark gap, milliampere meter and a switchboard, to which is attached the rheostat, ampere meter, fuses and switches. The various parts of the unit are permanently connected in the case so that when the front and rear doors are opened and connection is made with the cable supplying the current from the generator to the transformer, the unit is ready for operation.



INTERIOR OF ROENTGEN-RAY TRUCK (REAR VIEW).

A. Red glass window. B. Developing shelf. C. Fixing shelf. D. Fixing tank. E. Drawers for electric material, *x*-ray accessories and chemicals. F. & G. Packing boxes for *x*-ray tubes and valves. H. Compartments for *x*-ray plates and accessories. J. Ledoux-Lebard Transformer Unit. K. Lead-lined box for fluoroscopic operating table. L. Tube stand. M. *X*-ray and fluoroscopic operating tables. N. Tools and *x*-ray accessories.

Owing to its simplicity the installation requires very little care. Once a day it is necessary to place a drop of lubricating oil in the motor of the mercury interrupter, to change the illuminating gas or ether vapor, and to clean the mercury as often as indicated. Observance of these simple precautions is all that is required to insure smooth running of the apparatus.

Fluoroscopic Operating Unit.—This unit is designed for surgical operation under the screen and is placed in the operating room, the current being conveyed from the transformer in the *x*-ray room to the unit by means of high tension insulated cables. The unit comprises a light fluoroscopic table and a tube holder box. The framework of the table is cast iron and its top is covered with a thin sheet of aluminum. Underneath the table is a lead-lined roentgen-ray tube box mounted on rollers which runs from one extremity of the table to the other on a small track. Provision is also made for lateral shifting of the tube. A Dessane bonnet is furnished with the equipment. This is worn by the roentgenologist for fluoroscopic observations which are made in the usual brilliant light of the surgical operating room.

Localizing Sets.—The localizing equipment furnished by the French *Service de Santé* consists of the Haret rule, the pierced screen, the Hirtz compass (radioscopic modification) and a collar fitted to the horizontal arm support of the cupule for the 26 degree method. In addition to these we have added the profundometer method,[1] the trocar and cannula method[2] and the device required for the Strohl method.

Installation of the Roentgenological Equipment.—The installation of the roentgenological equipment depends on the conditions under which the hospital is operating. If it is being used as an autonome unit, the roentgen-ray apparatus is installed in a room of the demountable barrack, adjacent to the operating room. If the hospital is operating in permanent buildings, such as barracks, a château, abbey or evacuation hospital, the apparatus would be assembled in a room or tent in proximity to the operating pavilion. At present, our hospital is installed partly in barracks and tents, the roentgen-ray department occupying a room adjacent to the operating pavilion and in the same barrack.

When the roentgen-ray room of the demountable barrack is utilized, absolute darkness is obtained by means of a large, black curtain impervious to light. In our present installation, a fixed barrack, the light is excluded by the use of shutters.

The Handling of the Wounded in the Roentgen-Ray Room.—The method of handling the wounded varies according to the injury. Where the patient's injuries are grave and he is carried into the roentgen-ray room on a stretcher no effort is made to move him, the heavy canvas of the stretcher offering practically no resistance to the ray. If the patient is only slightly wounded, and he can be moved from the stretcher without pain, he is placed directly on the table. Splints are not removed unless it is necessary for a more accurate examination. Bandages of the injured parts are removed when it is necessary to place marks on the skin for the guidance of the surgeon.

Skin Marking.—Numerous methods of marking localizing points on the skin have been described. A method which we have found valuable is the combined use of a saturated solution of pyrogallic acid and 2 per cent silver nitrate. A simple instrument employed for applying the solutions to the skin consists of a large darning needle fused in the end of a piece of glass tubing five inches long. The solutions are applied as follows: The pyrogallic acid solution is first lightly applied to the skin by means of the marking instrument at the point of emergence of the normal ray; then by means of a second similar instrument the silver nitrate is traced over the mark made by the first solution. The solutions thus applied made a distinct

(1) Flint—*Annals of Surgery*, Aug., 1916.
(2) Ibid.—*Military Surgeon*, March, 1917.

black mark which, after a few minutes of drying, cannot be washed off in the preparation of the patient for operation, and is distinctly visible after the application of iodine to the field of operation.

METHODS OF LOCALIZATION

In the localization and extraction of projectiles, two distinct problems have to be considered by the roentgenologist and surgeon: First, the recent wounds in which the tract of the projectile still exists; second, the healed wounds in which the tract is cicatrized and obliterated and, therefore, can no longer serve as a guide during the debridement and excision of the wound.

In wounds of the first type when the tract can be utilized as a secondary control in localizing the foreign body, a simple localization giving its size and depth beneath a skin point is usually sufficient, because, during the operation in these cases, it is really the tract that locates the foreign body. The localization, however, is none the less important, as it tells the operator the position and depth of the foreign body with reference to the wound of entrance. It enables him to make his incision intelligently so as to provide the best exposure to safeguard important structures, and to give himself the best surgical approach for the excision of all traumatized and infected tissues. If, however, the tract cannot be utilized as a guide, as in certain wounds of the chest or abdomen where the surgeon is forced to make an operative approach on the side of the body opposite the wound of entrance, or where the tract is obliterated, as in the case of healed-in projectiles, a simple depth localization will not suffice, because with a skin point localization and a healed-in projectile, the operator, in fifty per cent of the cases, will fail to find the foreign body or he will mutilate the tissues uselessly in a prolonged search for it. In these cases more complicated methods are required to give the surgeon special data as to the relations and position of the foreign body, and to furnish as well some physical guide to the projectile during the operation.

For the first type of wounds, particularly where one is faced with the problem of many wounded men coming in at one time, the methods of localization which will prove the best are those which combine simplicity and rapidity of technique with the maximum degree of accuracy. In our experience the Haret, Strohl and "26-degree" methods have fulfilled these requirements. Of these we have adopted the 26-degree method as a routine procedure. When, however, the angulating device required for the 26-degree method is not available, the Strohl or Haret methods yield rapid and satisfactory results.

For the healed-in projectiles and the type of cases which present special problems, the Hirtz compass (radioscopic modification) or the profondometer method is indicated, as these methods not only give the depth of the projectile, but are fitted with special apparatus for guidance during the operation. The guide of the compass and of the profundometer directs the surgeon to the projectile.

Special Points to be Observed in the Localization of Projectiles.—To render the greatest possible aid to the surgeon the localization should always be made in the plane that furnishes the best surgical approach. In fresh wounds, the surgical approach is almost invariably along the tract. In all cases the relation of the projectile to contiguous anatomical structures, the depth, position, size and number of projectiles should be tersely and accurately stated. The position of the part at the time the localization is made should be carefully recorded, as any change in the position leads to a disturbance in the relation of the skin marks to the projectile. To differentiate between deep and superficial projectiles distinguishing skin marks may be used. In our service, a cross signifies that the projectile is deeply situated, and a small circle indicates that it lies superficially.

Roentgenological Records. — We have adopted a simple method of dictating the roentgenological data during the examination of patients. A box, curtained at its open end, is mounted on a small table in one corner of the *x*-ray room. This box is wired and its interior illuminated by a small, red, electric lamp so that the scribe may take dictation from the roentgenologist without the introduction of light during the examination. By this method the data are compiled as the examination progresses and all delays and interruptions are avoided. All reports are made in duplicate, one copy accompanying the patient to the operating room, forming part of his clinical record; the second copy is retained by the roentgenologist. All copies retained are cross-indexed and filed in the usual manner.

RADIO-ACTIVITY

The Parent of Actinium.—Soddy, F. and Cranston, J. A. (*Roy. Soc., Proc.* 94, pp. 384–404, June 1, 1918.) In a full historical introduction, the data obtained in 1909 relative to the rays and products of uranium X are discussed in so far as they throw light on the various possible modes of origin of actinium. The minute growth of actinium previously put on record (see Abs. 1075, 1913) as having been observed in the old uranium preparations has been confirmed by their later history and is now established beyond doubt.

Uranium X_2 can be separated from UrX_1 by sublimation in a current of air charged with vapors of carbon tetrachloride at a temperature below visible red-heat. 470 gm. of a very pure Indian pitchblende were similarly treated, in the expectation of removing eka-tantalum, isotopic with UrX_2 and giving actinium in an *a*-ray change of long period. The preparations so obtained were initially free from Ac, but one of them has produced it continuously with the lapse of time. A direct comparison of the amount of Ac in this preparation after the lapse of two and a half years with that in the original pitchblende showed that it was equal to that in about 0.25 gm. On the assumption that eka-tantalum and actinium are both long-lived, that no intermediate members intervene between them, and that the preparation contained the whole of the parent Ac in the original mineral, the period of average life of Ac is calculated to be 5000 years. Nothing can yet be said definitely as to the period of the parent.

A second preparation separated from Joachimsthal pitchblende, the treatment of which commenced in 1903 and ended in 1914 with the carbon tetrachloride sublimation, has given a similar growth of actinium. The work was undertaken to test and confirm the view that the parent of Ac occupies the eka-tantalum place in the Periodic Table, and gives actinium in an *a*-ray change of long period, being itself formed as the product of UrY, discovered by Antonoff, who suggested that it was the first member of the Ac series. But this mode of origin of actinium, though at present the most probable, has not yet been conclusively established to the exclusion of all the other possible modes of origin, discussed in the historical introduction.—From *Science Abstracts*, Vol. XXI, par. 8.

THE PHYSICAL CHARACTERISTICS OF ROENTGEN-RAY INTENSIFYING SCREENS AS APPLIED TO ROENTGENOLOGY

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THE USE of fluorescent screens for the intensification of exposure is a rather widespread practice and is of considerable importance in roentgenology. In spite of the general use of these screens, however, in quite a variety of work, very little has been done in the study of the fundamental laws of such a system. Shearer[1], Edwards[2], Baker[3], and others, have contributed excellent papers to the general fund of knowledge from a strictly utilitarian standpoint. Recently Sheppard[4] advanced some interesting theories regarding conditions for the fluorescent state.

In a previous paper the author described a method which he had developed for the precise study of the reactions of a photographic plate to roentgen rays. The present paper is a continuation of the work begun in the first paper, being a study of the functions of the various factors in the intensifying screen system.

When roentgen rays strike the emulsion of a photographic plate, less than 1 per cent of their energy is absorbed to cause the formation of a latent image, the remaining percentage passing through without performing any useful function. Any method, then, which utilizes this waste energy and returns it to the plate in a photographically active form, is of considerable value. Such is the function of fluorescent intensifying screens. A large part of the energy of the beam transmitted by the object rayed is absorbed by the screen and returned to the plate in a proportion governed by several laws to be discussed later.

Two types of fluorescent screens may be utilized in such a process. The first type is one in which the emitted or fluorescent radiation is still of that frequency usually termed *x*-rays—that is, characteristic high frequency radiation. As is well known, such a phenomenon is dependent on the atom of the emitting substance alone. The second type is where the emitted fluorescent radiation is of such wave-length that the energy falls within the ultra violet and visible regions of the "ordinary" spectrum. In this case the fluorescence no longer seems particularly dependent on the individual atom, but rather on the arrangement of atoms in the molecular structure of the material. Of these two, the second is by far the more efficient for use in practical roentgenography, and is the only one considered in the present paper.

The general phenomenon of fluorescence is one which has commanded the attention of a number of investigators, chief among whom are Herschel, Stokes, Wood, Wiedeman, and Nichols and Merritt. Of these Nichols and Merritt have done the most complete quantitative work.

Briefly defined, fluorescence is a phenomenon in which radiant energy of one particular wave length is absorbed by a material and emitted again as radiant energy of a longer wave length. Fluorescence takes place only while the exciting radiation is allowed to impinge on the material. It is thus different from the phenomenon of phosphorescence in which the time-lag between excitation and emission may be considerable.

Of the materials which fluoresce to roentgen rays in the range of frequencies from the ultra violet to the red, there are only a few which can be used efficiently for photographic intensification. All of

* Read before the nineteenth annual meeting of the American Roentgen Ray Society, Chattanooga, Tenn., September, 1918.

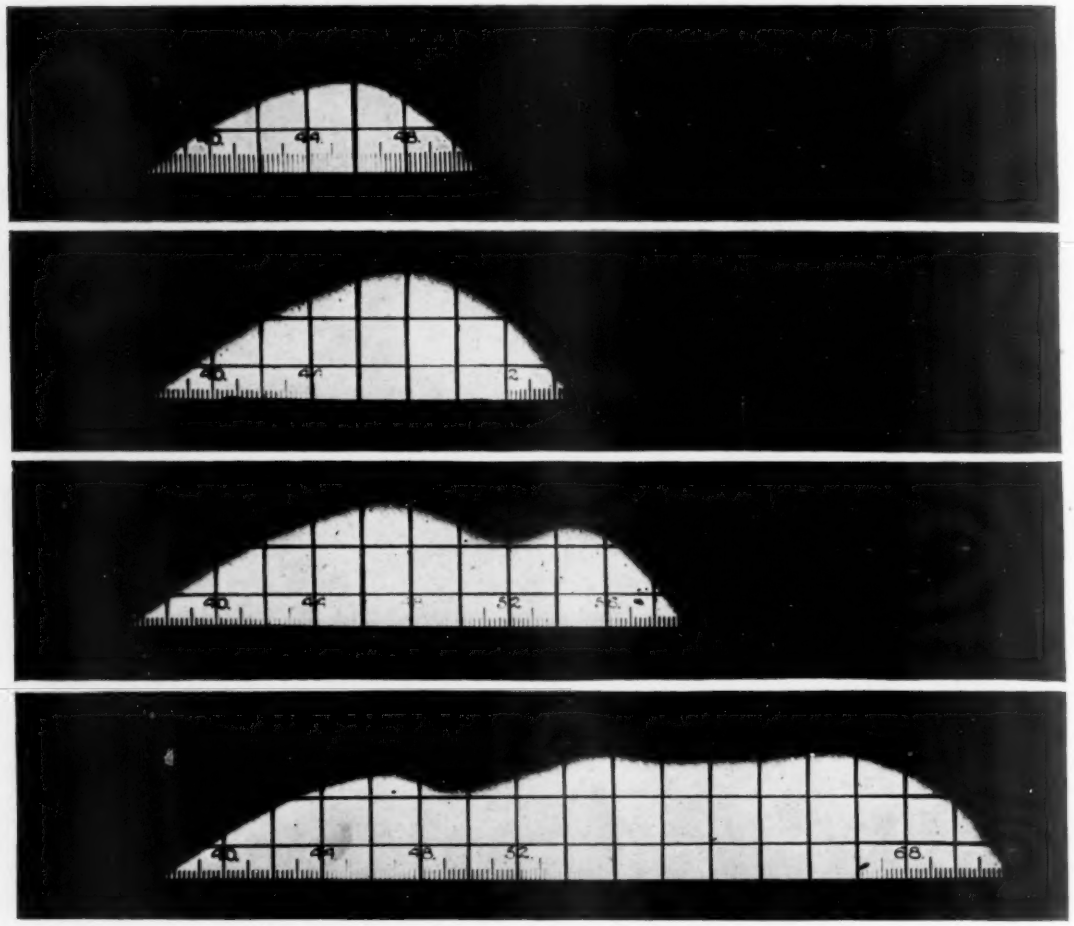

FIG. 1.

1. Roentgen Ray Plate.
2. Ordinary Plate.
3. Ortho-chromatic Plate.
4. Pan-chromatic Plate.

these substances must be in the crystalline state. Barium-platino-cyanide, barium salicylate, calcium tungstate, molybdenum tungstate, magnesium tungstate and some double tungstates of these metals fluoresce to a greater or less extent to roentgen rays, and the radiation is more or less active photographically. Of these materials crystalline calcium tungstate is by far the best with present photographic roentgen-ray materials.

The salt is usually powdered and coated with suitable binder on a support of some material of slight roentgen-ray absorption, such as cardboard or celluloid. This screen is then placed in contact with the photographic surface and exposure made through either the screen or the photographic plate or film.

The efficiency of any radiator as a source of photographic stimulation depends primarily on the comparative spectral distribution of the energy of the radiator and the spectral sensibility of the particular photographic plates used. While these relations have not been determined as yet on an equal energy basis for roentgen-ray materials, qualitative analyses have been made.

In Fig. 1 are shown the spectral sensi-

bilities to white light of an (a) *x*-ray plate, (b) a fast ordinary plate, (c) an orthochromatic plate, and (d) a pan-chromatic plate.

The fluorescent spectra of calcium tungstate have been studied under the following conditions. The screens used were commercial types. Spectra were obtained using a Hilger quartz spectrograph on Seed *X*-ray, Seed 30 and Wratten panchromatic plates. The illustrations shown were made on Seed 30; the spectral distribution of photographic energy in the fluorescence does not, however, extend appreciably further toward the red than is shown on these photographs. The screen was placed immediately in front of the slit and the *x*-ray tube in front of the screen as shown in the diagram (Fig. 2). A Coolidge tube of medium focus was used, the length of exposures averaging 1000 milliampere minutes at a distance of 8 inches from the target to the screen. The photographic plate was carefully shielded from stray radiation during the long exposures, which, in some cases, were for 24 hours.

Spectrograms were made with the tube operating at 40 K. V., 60 K. V., and 80 K. V. (R. M. S.). These are illustrated in Fig. 3, losing, however, by reproduction. In Fig. 4, the spectrum at 60 K. V. is graphically shown in a relative scale compared with the plate sensibility curves of the previously mentioned photographic materials. An inspection of these curves will enable one to pick out the plate most efficient for use with the screen.

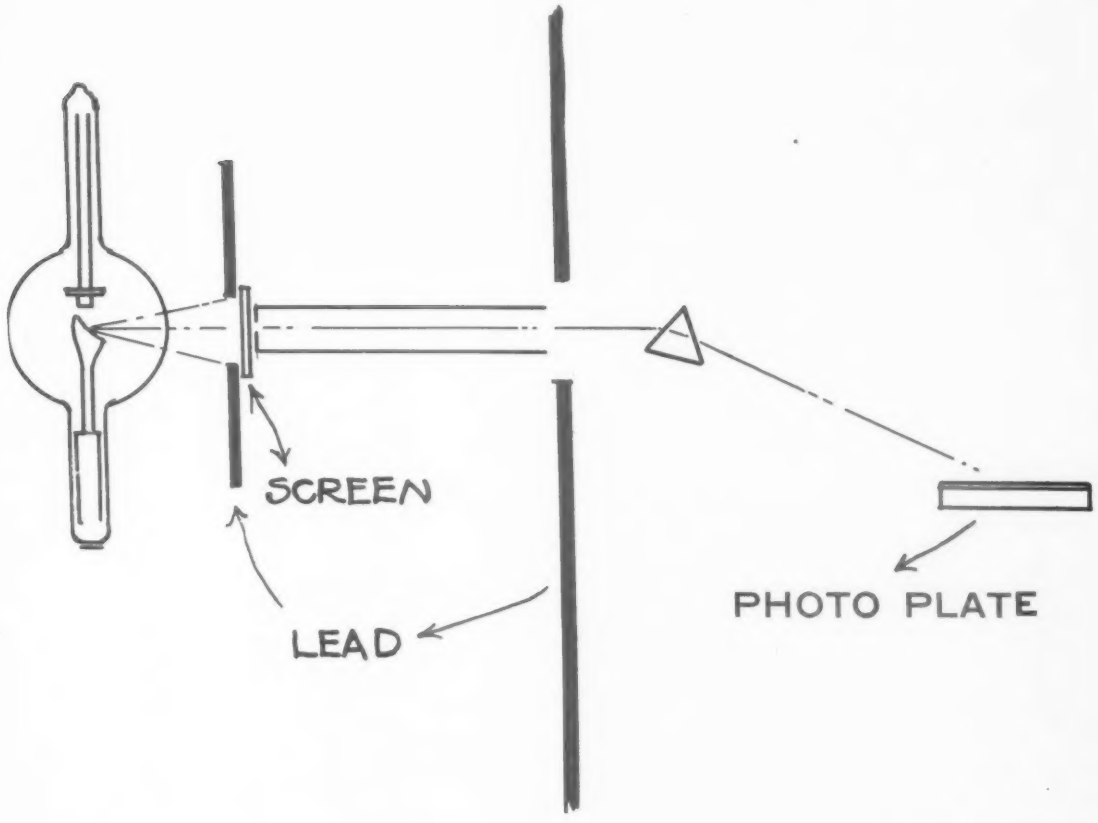

FIG. 2.

However, in a final consideration of efficiency, the sensitiveness of the material to the direct roentgen-ray beam must be given weight. It has been found that in a negative made from a screen system, about 20 per cent of the exposure is due to the absorbed energy of the direct rays, the remaining 80 per cent being supplied by the screen fluorescence. Hence, to decide the maximum efficiency in the case where the ratios of the screen fluorescence and plate spectral sensibility are the same for two photographic materials, their relative sensitiveness to roentgen rays alone should be considered.

As may be seen from the spectra in Fig. 2, the output of photographically suitable radiant energy increases with voltage. It also increases with current to a saturation value, dependent on the particular screen used. The limiting voltage, however, which it is permissible to use in practical roentgenography, is governed by the absorption of the object roentgenographed. That is, in the case of the average picture of body parts, in order to absorb enough of the incident *x*-ray beam to differentiate fine detail, the penetrating ability of the beam should be of a certain minimum value, of necessity limiting the tube voltage.

As to the technique of using a screen, the best practice is to expose through the support of the emulsion which is in contact with the surface of the fluorescing screen. Hence it follows that the support must be one of minimum opacity to roentgen-rays. In the case of two emulsions of equal sensitiveness, one on glass and the other on flexible film, the latter support should be used as it is more transparent to roentgen-rays.

Recently there has been considerable discussion among roentgenologists as to the efficiency of using double intensifying screens; that is, a screen system in which a photographic film is placed between the active surfaces of two intensifying screens, the exposure being made through one screen. The writer has studied the laws of such a screen system and has found that an increased efficiency over a single screen system exists only between rather narrow limits. It has been found that, using the average screens available for such work, the radiation must be of a rather penetrating type before the absorption of the front screen is slight enough not to have a great effect on the efficiency; indeed, it was found that, using a radiation governed by a 4½-inch spark gap or less, the absorption of the front screen was so great as to make the resulting effective exposure less than it would have been if a single screen had been used in the usual way.

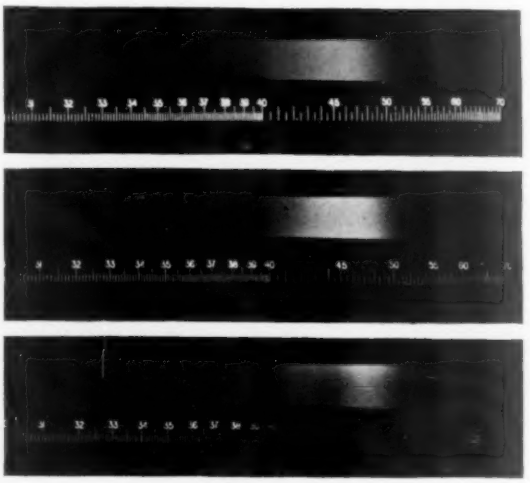

FIG. 3.

1. 40 K. V.
2. 60 K. V.
3. 80 K. V.

Beginning with a five-inch spark gap and on, the system began to gain efficiency over the case of a single screen until, using a six-inch gap, there was a noticeable increase in exposure as measured by the photographic result. With a further increase of penetration this efficiency increases. But inasmuch as secondary effects, such as scattering and hence graininess, increase also with this increasing penetration there is a certain maximum value which cannot be exceeded. This leaves working limits of between five inches and six and one-half inches for the spark gap factor. The gain of exposure under this condition is about

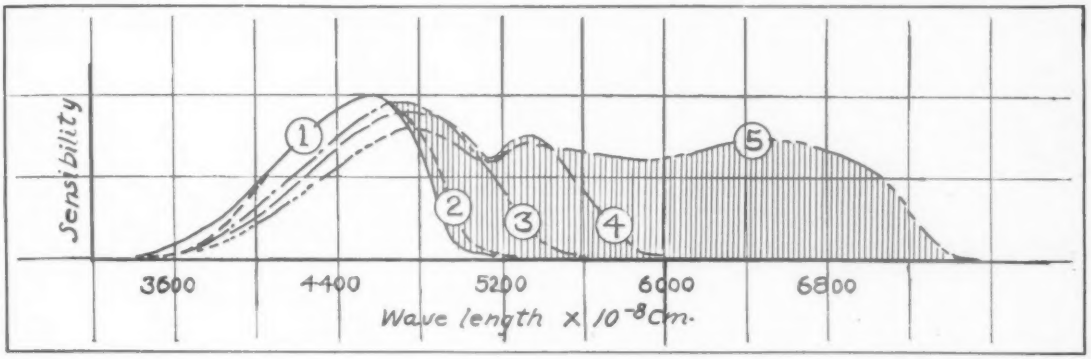

FIG. 4.

1. Emission Spectrum Ca'cium Tungstate.
2. Sensibility *X*-Ray Plate.
3. Sensibility Ordinary Plate.
4. Sensibility Ortho-chromatic Plate.
5. Sensibility Pan-chromatic Plate.

fifty to one hundred per cent, depending upon the individual screens. The value of such a method, then, depends upon the value of this gain in exposure. In cases where the exposure is of necessity long and relatively great, penetration must be used, such as in the radiography of the spine, head, etc. This amount of increase of exposure is, perhaps, desirable enough to take advantage of.

There is just one more factor which functions in obtaining efficiency with a screen system. That is the development. As brought out by the author in the paper previously mentioned, exposure in the case where a screen is used is mostly on the surface of the photographic emulsion; hence development proceeds differently from that in the case of exposure to roentgen rays where the effect is distributed evenly through the material. There is a tendency to over-expose and under-develop screen negatives, thereby failing to get the contrast and snap from a screen negative which is present in a direct negative. Development of a screen negative should be fully as long as that of a direct negative and the exposure timed so that this may be done.

NOTE—Since writing the foregoing paper double-coated films have been developed in the laboratories of the Eastman Kodak Company which make it necessary to add a few remarks to the portion of the paper devoted to double screen technique. It is found that by using this material, which is coated on both sides of the support, much added efficiency is gained in such a system by reason of the fluorescence acting directly from screen to emulsion in both cases.

The work in the foregoing paper was based on experiences with single-coated films. For example, it has been found possible to radiograph satisfactorily the chest in one second at 28 inches distance, using the Army type of Coolidge Radiator Tube run at a 5-inch gap and ten milliamperes. The writer hopes to describe the possibilities of some interesting experiments under way in this connection in a later paper.—[M. B. H.]

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TRANSLATIONS & ABSTRACTS

FISCHER, I. F. Examination of Gall-Stones by Roentgen Rays. (*Nord. Med. Ark.*, Stockholm, 1917, Vol. I, Kirurgi, No. 12. *Surg., Gynec. & Obst.*, Vol. XXVII, No. 3.)

Renal calculi, as a rule, are more dense than gall-stones, and produce a much stronger shadow on the roentgen plate. Also the anatomic location of gall-stones prevents them from appearing on the plate.

In the Bispebjaerg Hospital, Copenhagen, for the past four years all patients presenting symptoms of gall-stones have been examined by roentgen rays. The patients numbered 141. The roentgenograms were positive in 11 cases. Of these eight were operated upon but stones were found in six only. Of the 141, fifty-four patients were operated upon and stones were found in thirty-nine. The low positive number of cases in which shadows of stones were seen on the roentgen plate shows very clearly that no weight whatever should be attached to the negative result of the roentgen examination, which showed calculi in only about eight per cent. of those examined. Even in three of the cases in which a positive roentgenogram was verified by operation, the number of stones found greatly exceeded those shown on the plate. This is accounted for by the fact that the calculi present in the same gall-bladder have different powers of absorption for the roentgen rays.

The author gives a number of illustrations of the appearance which gall-stones give on the plate. He also describes the errors which might be made in interpreting these shadows. The calcareousness of the stone, and not its size, is the determining factor in the vividness of the shadow cast on the plate.

Experiments show that no small number of the gall-stones embedded in a gall-bladder with abundant gall will not be demonstrable by the roentgen rays, because their chemical composition gives them less power of absorbing the rays than that possessed by the liquid. It is impossible to fix a limit of the percentage of gall-stones the demonstrability of which is within the margin of possibility. It will depend on the technique applied. Any improvement of technique will improve the roentgenologic diagnosis of gall-stones. W. A. BRENNAN.

BOGGS, R. H. The Treatment of Carcinoma of the Breast by the Roentgen Rays. (*Interst. M. J.*, 1918, Vol. XXV, p. 210. *Surg., Gynec. & Obst.*, Vol. XXVII, No. 3.)

The author states that roentgenotherapy is today a recognized method in the treatment of postoperative cases, recurrent and metastatic, primary inoperable and primary cases which do not permit operation. He believes that, even in early cases, operation should be supplemented by roentgenotherapy, thereby preventing from 25 to 50 per cent of recurrences. To be effective this radiation should be done thoroughly by competent operators, giving full physiological doses to every chain of lymphatics draining the breast as well as to the opposite side of the body. Roentgen radiation produces a sclerosis of the lymphatics which in itself tends to oppose cancer dissemination. Such treatment is of value as an anteoperative as well as postoperative procedure, often rendering an advanced case operable; if deep metastases have not taken place, more permanent cures can be surgically obtained.

The author uses the cross-fire method as much as possible. Three or four areas on anterior chest wall and the liver area are given one anteriorly, laterally, and posteriorly. The axilla is given three or four doses and the lateral chest wall below the axilla an additional one. The supraclavicular region is divided into four areas. The supra- and subscapular areas on the affected side each receive a full dose. The mediastinum should receive one or two treatments through the back. The opposite side is rayed according to indications and never receives less than from four to ninety-eight treatments during the course. The epigastric region must never be omitted, as this is one of the avenues by which the liver and pelvic viscera metastasize.

Since operation has reached its limit and since ultraradical operations are not practical until some better form of treatment is discovered, the splendid results achieved through radiation furnish more than sufficient reason for giving every case of carcinoma of the breast postroentgen treatment. In recurrent and inoperable cases, a temporary cure can often be produced. ADOLPH HARTUNG.

HARTWELL, J. A., and BUTLER, ETHAN F. War Surgery and the Civil Hospitals. (*Surg., Gynec. & Obst.*, October, 1918, Vol. XXVII, No. 4.)

We quote the following *in extenso* as it discusses the relationship between hospital management, physicians and patients as it has been developed by the war.

"The war has demonstrated beyond further debate that corresponding progress can only be made in our civil hospitals when the patient is made the center of all their activities. The wards and operating room must have a staff of laboratory men just as they have a staff of surgeons. The art of surgery and the sciences on which it is founded cannot be compassed by the mind of one man. The laboratory scientist will become more proficient by close contact with the surgeon, and the surgeon will profit equally. Both these staffs must be largely composed of full time men. Our military surgeons and laboratory men find no distracting calls outside the hospital. No one can conceive that the advance made in three years would have been possible if the best trained minds had spent three or four hours a day at the hospital, and then left the patients to get on as best they might under the sole care of juniors and internes during the remaining twenty hours. It may be argued that to organize our hospitals on such lines is financially impossible. Such argument cannot be maintained. Money has always been forthcoming to foster any well thought out plan for the betterment of education and the best care of the sick and injured. Had the lessons which this war is teaching in treatment of the injured been in force during the past two decades, the money saved to our industries would have more than met the expense involved in learning them. The duty of spreading this teaching lies with our profession. Upon our success in this line depends our ability to give to the country one of the offsetting benefits with which war, to some extent, balances its horrors. Another phase of organization more easily accomplished, has been placed in evidence in the military hospital. Every service has had at its disposal well trained mechanics and carpenters. Most surgeons in civil hospitals have at some time vainly struggled to have constructed a simple piece of apparatus to meet some special requirement. There was no well equipped shop at hand with a competent workman who could promptly furnish the apparatus and, at the same time, suggest ways of meeting mechanical problems for which his training fitted him. Trustees of hospitals have been very loath to recognize that other artisans than surgeons may be advantageously employed in a surgical service. The results overseas should be very effective in convincing them that this view is no longer tenable."

CARMAN, R. D. Roentgenologic Aspects of Hour-Glass Stomach. (*Surg., Gynec. & Obst.*, October, 1918, Vol. XXVII, No. 4.)

Conclusions:—(1) Hour-glass stomach should not be considered a disease entity but an end-result of various pathologic processes, gastric and perigastric.

(2) The possibility of congenital hour-glass stomach must be admitted, although most cases reported have been questioned.

(3) The roentgenogram usually shows a much deeper constriction than is seen at operation, due to the fact that the organic narrowing is exaggerated by the spasm.

(4) Cases of spasmodic hour-glass, whether intrinsic or extrinsic in cause, are not seen by the surgeon, because they are relaxed by the narcosis. Therefore, if the hour-glass is the only roentgen sign present, the first thing to do is to exclude extrinsic causes.

(5) Belladonna or atropine does not differentiate between the organic and intrinsic types of spasmodic hour-glass stomach.

(6) Belladonna or atropine to physiologic effect will differentiate between the intrinsic and extrinsic types of spasmodic hour-glass stomach.

(7) Operations have proved that the organic type is the most common. However, the spasmodic, when intrinsic in origin, is just as important from a diagnostic standpoint as the organic.

(8) The varieties of hour-glass stomach, therefore, admit of the following subdivision:

(A) Congenital.

(B) Acquired.

(1) *Organic:* Constriction due to structural changes in or about the stomach. Causes: ulcer, scar of healed ulcer, perigastric adhesions, cancer, syphilis, corrosives, resection, gastrostomy, congenital (?).

(2) *Spasmodic* (or functional): Cramp of

the gastric muscle without structural change. Two types: (a) intrinsic; cramp directly produced by lesions in the stomach; causes practically the same as those of organic hour-glass; (b) extrinsic; cramp indirectly produced by causes outside the stomach: duodenal ulcer, diseases of the gall-bladder, disease of the appendix, neuroses, tabes, lead intoxication, morphine, nicotine.

(c) *Pseudo-hour-glass*: Simulating the hour-glass form without either spasm or structural change in the stomach. Causes: contraction of abdominal muscles, pressure of stomach against the spine, tumors outside the stomach, atonic stomach, gas and fecal matter in the bowel.

KELLY, HOWARD A. Two Hundred and Ten Fibroid Tumors Treated by Radium. (*Surg., Gynec. & Obst.*, October, 1918, Vol. XXVII, No. 4.)

The life history of a uterine fibroid possesses three striking clinical characteristics. They can nearly always be considered benign, they give trouble, either by compressing neighboring organs or by hemorrhage. The incidence of malignancy is small and the presence of carcinomatous or sarcomatous changes is almost always excluded by curettage and the microscope. The author contends that the following has been accomplished by radium treatment:

(1) Control of hemorrhage and the checking of menstruation.

(2) The shrinkage of the tumors.

(3) In many instances the disappearance of the tumors.

(4) In some cases (even after two years) the return of menstruation, either normal or scanty.

He states that when there is any doubt about the diagnosis, operation is to be elected in preference to radiation. Of the 210 cases, 146 were 40 years of age and over. Sixty-four were under 40 years of age.

He also states that results are obtained just as easily in young women as in those who are older.

In group I, 146 patients 40 years of age or over, 66 are at the present time cured. In 48 the tumor has diminished in size and the symptoms have been relieved.

Group II includes 64 fibroid tumor patients under 40 years of age. In 28, the tumor has either disappeared or has practically gone. In four of this group menstruation is known to have returned. In 16 patients the tumor has decreased in size.

In the discussion of technique Dr. Kelly states that it is best to produce an amenorrhea which shall last until the fibroid is gone. A single intra-uterine dose of 1500 millicurie hours is sufficient to produce an amenorrhea and shrinkage or complete disappearance of the tumor. An equal effect is produced with a gram of radium four inches from the skin, distributed at various points over the tumor for about 24 hours. It is not advisable to give more than 1500 millicurie hours inside the uterus.

For intra-uterine treatment a small glass bulb is set in the end of a short metal tube which is thick enough to screen off all but the gamma rays. This is then screwed to the end of an ordinary uterine sound and covered by a rubber cot. Then either with or without anesthesia the cervix is dilated and the sound is introduced to the fundus. These applicators remain not longer than a half hour in each spot.

In external treatment from 4 to 5 grams of radium are used, and the entire treatment is given in from five to six hours.

SGOBBO, F. P. The Action of *X*-rays in the Formation of Bone Callus. (*Riforma. med., Napoli*, 1918, Vol. XXXIV, p. 282, *Surg., Gynec. & Obst.*, Vol. XXVII, No. 4.)

The author gives the details of eight experimental studies to note the effects of roentgen-rays in the healing of fractured limbs of dogs.

The only work along this line which the author is able to trace is that of Cluzet and Dubreuil, who, in 1913, found by experiments on dogs that strong roentgen-ray irradiation made before and after fracture notably retarded the formation of callus and consolidation of the fracture. Sgobbo's researches have in every way confirmed these findings; while with single dose alone Cluzet and Dubreuil saw a retardation in the consolidation and formation of callus, Sgobbo by using minimum varying doses obtained, according to the dosage, retardation, limitation in the development, or even absence of callus. Even a single minimum dosage has effected retardation. The question as to whether the dosage of roentgen-rays used in practice for roentgenoscopic or roentgenographic research gives a similar

result is now being investigated by Sgobbo; also the manner in which the harmful action of *x*-ray exerted on the various elements concerned in the formation of callus.

Twenty-two illustrative figures accompany the article.

EISENDRATH, DANIEL N., A.B., F.A.C.S., Chicago. The Diagnosis of Ureteral Calculi. (*Surg., Gynec. & Obst.*, Vol. XXVII, No. 5.)

The chief object of this paper is a plea for the more frequent use of the roentgen ray. He speaks especially of the value of stereoscopic plates and also emphasizes the use of the opaque catheter and pyelography. He discusses what he terms intensification of suspicious shadows. The scheme was first suggested by Kuemmel. If a very faint shadow is found upon the plate, Kuemmel advised injection of material opaque to the roentgen ray in the region indicated by the shadow, so that if there is a uric acid stone, some of the opaque material will adhere to its surface. A plate is then made, when the shadow will be found more intense.

OCHSNER, A. J., M.D., F.A.C.S. The Practical Value of Electric Light in the Treatment of Infections. (*Surg., Gynec. & Obst.*, November, 1918, Vol. XXVII, No. 5.)

Dr. Ochsner relates his personal experience as follows:

"Four years ago, I suffered from a violent infection of my elbow and it became necessary to expose the ulnar nerve when the abscess was laid open. This gave rise to intense neuralgic pains which continued for many days without cessation, notwithstanding the use of wet and dry heat. At the suggestion of Dr. Saurenhaus, I applied an electric light apparatus. Within an hour the pain disappeared, and did not return. My natural skepticism regarding the effect of all therapeutic measures led me to think this might be merely a coincidence, and that possibly the pain would have subsided at this time even if we had not employed the electric light.

"During the past four years, however, I have had an opportunity to test this method at the Augustana Hospital in 78 similar cases of infection of the extremities. Invariably the pain promptly disappeared. Sixty-one of these cases were infections of the upper extremity, and 17 were of the foot."

KRETSCHMER, HERMAN L., M.D., F.A.C.S., Chicago. A New Procedure for the Localization of Ureteral Stone. (*Surg., Gynec. & Obst.*, Vol. XXVII, No. 5.)

This consists of catheterization of the ureter suspected to contain stone by an opaque catheter, followed by roentgen examination. Two exposures are made on the same plate. If the suspected shadow is a stone, it retains its relative position to the opaque catheter. If it is not a stone, it will be separated from the catheter.

KREUSCHER, PHILIP H., M.D., Chicago. A Study of the Development of the Epiphysis. (*Surg., Gynec. & Obst.*, Vol. XXVII, No. 5.)

The contention is made that much useless surgery is done before ossification of the epiphysis. The author does not mention the importance of always making a roentgen examination of the unaffected side for comparison with the affected one. He draws the following conclusions:

(1) That a thorough knowledge of the normal structures and their time of appearance is necessary in order to treat intelligently the abnormal conditions.

(2) That fractures of the epiphyseal line should be recognized early and reduced completely to avoid deformities.

(3) That injuries about the joints in the young must never be treated lightly or in a haphazard manner.

(4) That operative injury of the epiphyseal line is inexcusable with our present knowledge of its importance.

FRIEND, EMANUEL, M.D., F.A.C.S., Chicago. Subdiaphragmatic or Phrenic Abscess. (*Surg., Gynec. & Obst.*, Vol. XXVII, No. 5.)

The author attaches much importance to the roentgen ray findings which he interprets as follows:

"Roentgen-ray findings are those usually of an uneven level of the diaphragm on both sides; in other words, a marked bulging up-

ward on the affected side with an acute costophrenic angle, together with a marked shadow over the pus accumulation, and a shadow distinctly less between the accumulation and the diaphragm caused by gas when the causative agent is the colon bacillus."

Dr. Daniel N. Eisendrath, in discussing the paper, says that in 75 per cent or 80 per cent of the cases all of the methods of diagnosis are supplanted by the roentgen plate and fluoroscopic examination.

WELD, E. H. The Use of Sodium Bromide in Roentgenography. (*J. Am. M. Ass.*, Vol. LXXI, No. 14, p. 1111.)

The writer says the ideal medium should be non-toxic, non-irritating and easily soluble in urine, one that is easily sterilized and that keeps well under all conditions and one that is easily procurable at a reasonable cost.

He states that bromide salts are not as irritating as the iodides and that they do not act like foreign bodies as the silver salts. The sodium bromide apparently smears over the surface of the ureters, the minor calices of the kidneys and small saccules of an inflammatory bladder much better than thorium. He prefers to use a 25 per cent solution for the following reasons: (1) It is a bland solution and does not damage the kidney. (2) It casts a clear shadow, outlining the entire pelvis and ureter as well as, if not better than, other mediums thus far advocated. (3) It is less irritating to the pelvis and vesical mucosa than other mediums. (4) It is the least expensive, and is readily procured. (5) It is very easily prepared, and is readily sterilized by boiling.

HERNAMAN-JOHNSON, F. The Value of *X*-rays in the Diagnosis of Abdominal Disease. (*Med. Press.*, 1918, Vol. CV, p. 409.)

The author states that the roentgenologist should not be judged by the number and beauty of his plates, nor by his electrical equipment, but by his success in unraveling the diagnostic puzzles sent to him for solution. He gives several helpful suggestions in diagnostic procedures, such as the localization of a renal stone by the method used in determining the vertical depth of bullets.

In the opaque meal and enema he suggests that the patient be examined while leading his everyday life and eating his ordinary food, as pathological conditions can sometimes be noted. Previous to the barium meal it is well for the patient to live on finely divided food for a day or two to avoid undigested lumps.

He sums up the usefulness of the roentgen-ray along the following lines:

1. Urinary system. Calculus in the kidney, bladder and ureter. Enlargements, malformations, alterations in the position of the kidney.

2. Alimentary tract. Disorders of function, ulcers of the stomach and duodenum; by inference in early stages, by direct demonstration in the later. New growths which alter the form of the gastric or intestinal shadow. Correlation of tender spots with particular parts of the tract, e.g., the appendix.

3. Liver and gall-bladder. Alteration of the liver outline (with or without inflation of the colon). Demonstration of an enlarged gall-bladder. Demonstration of gall-stones in 10 per cent of cases.

4. Genital organs in the female. Malformations in the uterus have been shown by the injection of collargol, but the scope of this is limited. By the demonstration of the cecum and appendix indirect information is, however, often obtained. In certain cases of doubtful pregnancy assistance may be obtained, but only at a somewhat late period. Calcification of myomata may be detected.

5. Spleen. This organ is somewhat neglected by modern roentgenologists, though it is mentioned in the textbooks of fifteen years ago. The normal spleen is visible in children and in very thin adults. Enlargements can often be demonstrated. The existence of this viscus should not be forgotten when interpreting roentgen plates of the left abdomen.

C. B. HOLLINGS.

BOOK REVIEWS

UNITED STATES ARMY *X*-RAY MANUAL. Pp. 506. 219 illus. $4.00 Net. Paul B. Hoeber, New York.

This volume is the official army manual, authorized by the Surgeon-General, and prepared under the Division of Roentgenology. It is the successor to the very small manual which was hurriedly compiled at the beginning of the war, and is intended to be a guide to the roentgenologists who are doing the *x*-ray work in the military hospitals, and also as a textbook for instruction in military roentgenology.

The authors do not pretend that it is a complete treatise on roentgenology. They have aimed to present only the facts that have been established by experience and have avoided all controversial points. They have succeeded in producing a textbook which is above all things practical, and at the same time have not sacrificed anything of value.

The book is evidently a composite, produced by a number of men. One who is familiar with the various idiosyncrasies of our leading roentgenologists can easily detect their hands in many of the sections. This adds considerably to the interest in looking the volume through.

The first chapter, which includes nearly one-quarter of the entire book, is entitled "X-Ray Physics." It contains not only what is ordinarily included under this heading, but also sections on the care and operation of the various types of tubes, transformers, coils, etc., hints on dark-room technique, exposure-tables, and numerous points in practical technical roentgenology. The chapter is not written in the usual dry didactic fashion found in the average textbook, but it is evidently written with the object of making a firm impression on the minds of the readers, who some time may find it necessary to be practical electricians as well as physicians. The descriptions are interspersed with definite directions for operating, and looking for trouble. This chapter contains a very clear description of the Coolidge tube, its action, control and peculiarities. Also, there is a description of the new form of small, self-rectifying Coolidge tube, the so-called "radiator" type, which is arranged to rectify its own current, and runs at a small current, 5 to 10 Ma. on a 5-inch spark backup.

In a chapter on "New Apparatus" are described the various new appliances which have been developed for army purposes. The *U. S. Army Portable X-Ray Unit* consists of a portable power plant, a special type of army table, and a self-rectifying radiator type of tube. The power plant is a "Delco" outfit with gasoline engine. The *U. S. Army Bedside X-Ray Unit* is the other important contribution. This unit consists of a combined cabinet and tube stand, a radiator type of Coolidge tube, a special lead glass shield, and a transformer and control apparatus. All the complicated apparatus for rectification is absent. The transformer is designed to run on alternating current of any ordinary frequency, and a space is reserved in the bottom of the cabinet for a rotary converter, where only direct current is available. This unit has been of great value in the wards of the army hospitals. It is useful for both bedside radiography and fluoroscopy. The bedside unit is destined to revolutionize the method of doing portable *x*-ray work in civilian life after the war.

The chapters which follow are on standard positions in radiography, dangers and protection, and the technique of fluoroscopy.

The chapter on "Localization" is the clearest and best arranged textbook description of the numerous methods which the reviewer has had the privilege of seeing. The manual aims to present only certain standard methods which have been proven of value. These methods are grouped under six heads:

(A) Two wire, double tube-shift method.
(B) Parallax method.
(C) Tube-shift method with mechanical triangulation.
(D) Profundometer.
(E) Hirtz compass with accessory devices.
(F) Cannula and trocar with harpoon.

The first three groups are suitable for use in the evacuation hospitals where most of the work must be done with the fluoroscope. The last three are the methods for use in base hospitals. Proper accessories have been provided for these various methods in the regular army outfit, and these are all described and illustrated.

Methods of fluoroscopic assistance during operations are also described. For foreign bodies in the eye, the method of Sweet is

adopted, and his localizer apparatus carefully described. There is appended a very valuable table of the *depth of anatomical landmarks beneath the skin.*

The chapter on "Bones and Joints" is very clear and comprehensive, although condensed. The technique for various difficult exposures is well illustrated. The section on bone tumors is worthy of special attention. The differentiation is based on careful study of four "cardinal points": origin of the tumor, the presence or absence of bone production, the condition of the cortex, and the presence or absence of invasion of the neighboring tissues. The use of the so-called "law of probabilities" as an aid in bone diagnosis recalls one of our well-known pioneer roentgenologists.

The remainder of the volume is devoted to chapters on Sinuses and Mastoids, Teeth and Maxillæ, Thoracic Viscera, Urinary Tract, Gastro-Intestinal Tract, Measurement of *X*-ray Dosage, and Cutaneous *X*-ray Therapy.

All these chapters attempt to cover their entire fields fairly, though in some instances very briefly.

The facts regarding examination of the "thoracic viscera" are especially well presented. The attitude towards the diagnosis of early pulmonary tuberculosis is very sane, yet by no means ultra-conservative.

The section relating to cardiac disease is very clear. The method of heart measurement adopted by the cardio-vascular service at the Army Medical School is described, and in connection with this are printed the tables of heart measurements compiled by Dr. C. R. Bardeen. These tables form a valuable supplement to the very meager information that has been available up to the present time regarding cardiac measurements in the healthy.

The entire book is, of course, primarily a military manual. As such it contains many pages of directions for setting up apparatus, etc., which would be of service only with the standard army outfits. At the same time, however, we have an elementary textbook of general roentgenology which, from the practical point of view, is one of the best and clearest which has been published in any language. Practically every phase of the work is touched upon, and the essentials clearly brought out.

The manual will prove a valuable and dependable guide for the beginner in the field, and, at the same time, contains much of interest and profit for the experienced roentgenologist.

ISAAC GERBER.

HISTORY OF MEDICINE. Suggestions for Study and Bibliographic Data. By Fielding H. Garrison, A.B., M.D., Principal Assistant Librarian, Surgeon General's Office, Washington, D. C. Second edition revised and enlarged. Octavo of 905 pages with many portraits. W. B. Saunders Company, Philadelphia and London, 1917. Cloth, $6.50 net; Half Morocco, $8.00 net.

This excellent book, which now appears in its second revised and enlarged edition, shows evidence of an enormous amount of painstaking research for which the medical profession is greatly indebted to the distinguished author. No library is complete without this work.

It is with some disappointment, however, that the roentgenologist turns through the book in vain for any particular reference to his specialty. Only two brief references occur, if the index may be relied upon; yet the *x*-rays have come to play such an important part in the field of medicine of to-day that it does seem as if a brief history of the development of roentgenology should properly have been included. Of course, it may be argued that the roentgenologist is overestimating the dignity of his specialty.

The importance of the study of medical history is becoming more and more recognized. The publisher of our own journal is now engaged in a new venture, THE ANNALS OF MEDICAL HISTORY, edited by Dr. Francis R. Packard of Philadelphia.

A.W.CRANE.

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